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PHYSICAL MEDICINE

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(Formerly Archives of Physical Therapy)

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27th Annual Session
AMERICAN CONGRESS OF PHYSICAL MEDICINE

September 6, 7, 8, 9, 10, 1949

NETHERLAND PLAZA CINCINNATI, OHIO

VOLUME XXX MARCH, 1949 NO. 3

American Congress of Physical Medicine

27th Annual

Scientific and Clinical Session

Instruction Course

September 6, 7, 8, 9 and 10, 1949

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AMERICAN CONGRESS OF PHYSICAL MEDICINE

September 6, 7, 8, 9, 1949

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TENTATIVE SCHEDULE

TUESDAY September 6	WEDNESDAY September 7	THURSDAY September 8	FRIDAY September 9
10:00 to 10:50	8:30 to 9:20	8:30 to 9:20	8:30 to 9:20
11:00 to 11:50	9:30 to 10:20	9:30 to 10:20	9:30 to 10:20
3:00 to 3:50			
4:00 to 4:50			

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30 North Michigan Avenue, Chicago 2, Illinois

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Subscription — In the United States, its possessions, and Mexico, $7.00 yearly; Canada, $8.00; elsewhere, $10.00 the year.

Advertising rates on application. All advertising copy subject to acceptance by publication committee.

Published monthly at Chicago, Illinois, by American Congress of Physical Medicine.

Entered as Second Class Matter, February 15, 1945, at the Post Office at Chicago, Illinois, under the Act of March 3, 1879.

ORIGINAL ARTICLES

EDITOR OF THE MONTH

FRED B. MOOR, M.D.
Los Angeles, Calif.

Printed in U.S.A.

THE UNIVERSITY OF WISCONSIN MEDICAL SCHOOL

Section on Physical Medicine

Sponsors a Joint Meeting of the

Wisconsin Chapter of the American Physical Therapy Association

and

Wisconsin Occupational Therapy Association

at

The Service Memorial Institutes, Auditorium, Room 230

The University of Wisconsin Medical School

Saturday and Sunday, April 2 and 3, 1949 **Madison, Wisconsin**

PROGRAM

Saturday, April 2, 1949, Service Memorial Institutes, Room 230

1:30 p. m. Opening of the Meeting: Miss Norma Smith, President, Wisconsin Occupational Therapy Association

Mr. Charles Safford, President, Wisconsin Chapter, American Physical Therapy Association

1.45 p. m. Welcome:
William S. Middleton, M.D., Dean of the University of Wisconsin Medical School, Professor of Medicine

Harold M. Coon, M.D., Superintendent, State of Wisconsin General Hospital and Wisconsin Orthopedic Hospital for Children, Executive Secretary, University of Wisconsin Medical School, Professor of Hospital Administration

Harry D. Bouman, M. D., Professor of Physical Medicine, Medical Director, Section of Physical Medicine

2:15 p. m. Rehabilitation of the amputee
Henry H. Kessler, M.D., Director Hasbrouck Heights Amputee Clinic, Newark, New Jersey

3:15 p. m. Question period

3:30 p. m. Rehabilitation of the heart patient
Chester M. Kurtz, M.D., Associate Professor of Clinical Medicine (Cardiology), University of Wisconsin Medical School

4:15 p. m. Rehabilitation of the multiple sclerosis patient
Hans. H. Reese, M.D., Professor of Neuropsychiatry, University of Wisconsin Medical School

4:45 p. m. Business meetings
Wisconsin Chapter, American Physical Therapy Association and Wisconsin Occupational Therapy Association

6:30 p. m. Dinner, Wisconsin Memorial Union

Speaker: A. B. C. Knudson, M.D., Chief of Rehabilitation and Physical Medicine Division, Veterans Administration, Washington, D. C.

Subject: Physical Medicine and Rehabilitation in the Veterans Administration

Sunday, April 3, Service Memorial Institutes, Room 230

9:30 a. m. The rehabilitation of the tuberculous patient
Miss Borghild Hansen, Director of Occupational Therapy, University of Minnesota

10:30 a. m. The psychologic approach to a treatment program for the handicapped
Marc J. Musser, M.D., Associate Professor of Medicine (Psychosomatic Medicine), University of Wisconsin Medical School

11:00 a. m. Modern aspects of virus research in poliomyelitis
A. Fred Rasmussen, M.D., Associate Professor of Medical Microbiology, University of Wisconsin Medical School

Luncheon in Medical School cafeteria

2:00 p. m. Localization in the motor cortex
Clinton N. Woolsey, M.D., Charles Sumner Slichter Research Professor in Neurophysiology, University of Wisconsin Medical School

3:00 p. m. Electrical stimulation of motor cortex in man
Theodore C. Erickson, M.D., Associate Professor of Surgery (Neurosurgery), University of Wisconsin Medical School

3:30 p. m. The treatment of hyperhydrosis by iontophoresis
Harry D. Bouman, M.D., Professor of Physical Medicine, University of Wisconsin Medical School

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There will be no registration fee. Visitors from outside of Wisconsin will be welcome.

For advance registration and reservations for dinner and luncheon write: Miss Emma Zitzer, 207 N. Brooks Street, Madison 5, Wisconsin. Telephone 6-6207. It is suggested that those wishing to attend this meeting make hotel reservations early.

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THE EFFECTS OF MASSAGE ON THE CIRCULATION IN NORMAL AND PARALYZED EXTREMITIES *

KHALIL G. WAKIM, M.D., Ph.D.
Section on Physiology, Mayo Clinic

GORDON M. MARTIN, M.D.
Section on Physical Medicine, Mayo Clinic

JEAN C. TERRIER, M.D.
Special Fellow in Physical Medicine, Mayo Foundation

EARL C. ELKINS, M.D.
Section on Physical Medicine, Mayo Clinic

and

FRANK H. KRUSEN, M.D.
Section on Physical Medicine, Mayo Clinic

(With the Technical Assistance of Mr. A. N. Porter)

ROCHESTER, MINN.

Accompanying the rapid expansion of the entire field of physical medicine, massage has become a method of treatment that is being used increasingly. It is gradually acquiring a scientific basis, with various accepted technics and definite indications and contraindications for its use. Although its clinical results are undoubted, the specific physiologic factors involved in achieving them have been somewhat difficult to determine. Much of the early investigative work on massage was carried out in Europe during the latter part of the nineteenth century and during the period of development of the Swedish school of physical therapy.

Any discussion of the physiologic effects of massage on the human body emphasizes the idea that much of the benefit is dependent in large part on the reflex and mechanical effects of massage on the circulation. In 1900, Rosenthal (quoted by Pemberton[1]) reviewed the previous literature on the scientific basis of massage and reported that after massage a rise of 2 to 3 degrees (C.) in cutaneous temperature had been noted. Krogh[2] demonstrated the increase of the diameter and the permeability of the capillaries that follow mechanical stimulation in frogs and mammals. Carrier[3] also showed that light pressure resulted in an almost instant, transient capillary dilatation, whereas heavier pressure resulted in a more enduring dilatation, with a greater number of capillaries visible. Lange, Ehrich and Cohn[4] in 1930 reported that mechanical stimulation of embryonic blood vessels of the chick, before any nerve supply had developed, caused dilatation. Pemberton[1] reviewed the more recent investigative work on the physiologic effects of mas-

* Read at the Twenty-Sixth Annual Session of the American Congress of Physical Medicine, Washington, D. C., Sept. 10, 1948.

1. Pemberton, Ralph: Physiology of Massage, in: Handbook of Physical Medicine, ed. 1, Chicago, American Medical Association Press (Council on Physical Medicine), 1945, pp. 69-83.

2. Krogh, August: The Anatomy and Physiology of Capillaries, ed. 2, New Haven, Conn., Yale University Press, 1929.

3. Carrier, E. B.: Studies on the Physiology of Capillaries: V. The Reaction of the Human Skin Capillaries to Drugs and Other Stimuli, Am. J. Physiol. **61**:528 (Aug.) 1922.

4. Lange, Fritz; Ehrich, W., and Cohn, A. E.: Studies on the Blood Vessels in the Membranes of Chick Embryos: I. Absence of Nerves in the Vascular Membrane, J. Exper. Med. **52**:65 (July 1) 1930. Lange, Fritz: Studies on the Blood Vessels in the Membranes of Chick Embryos: II. Reactions of the Blood Vessels in the Vascular Membranes, ibid. **52**:73 (July 1) 1930. Cohn, A. E., and Lange, Fritz: Studies on the Blood Vessels in the Membranes of Chick Embryos: III. Anatomy and Physiology of the Blood Vessels at Different Ages, ibid. **52**:81 (July 1) 1930. Lange, Fritz: Studies on the Blood Vessels in the Membranes of Chick Embryos: IV. Modification of Irritability of the Blood Vessels, ibid. **52**:89 (July 1) 1930.

sage and concluded that the cumulative effect which massage exercises on various metabolic processes is probably due to a mechanical influence on the circulation of the part concerned. He stated that massage provokes a release of histamine and acetylcholine, accompanied with vasodilation, increased blood flow and a discharge of red blood cells from the spleen.

Clark and Swenson (quoted by Pemberton[1]) presented cinematographic studies on the effects of massage on the circulation in the capillaries of the rabbit's ear. They demonstrated a definite increase in the speed of the circulating elements, diapedesis of the leukocytes and increased exchange of substances between the blood stream and the tissue cells with an improved metabolism.

Clinically, it has been repeatedly observed that massage has a definite, though temporary, beneficial effect on returning fluid of edema of the extremities in cardiac decompensation. The lymphatics, as well as the blood vessels, are probably mechanically affected by the massage. Drinker[5] demonstrated a definite increase in lymphatic flow resulting from massage. Bauer, Short and Bennett[6] demonstrated that proteins injected into joints of dogs were removed by lymphatics and that massage and passive motion definitely increased the elimination of the proteins through these channels.

Most authors who have approached the physiologic aspects of the problem of massage have stressed the effects of this procedure on the venous and the lymphatic circulation. It is evident, indeed, that under the mechanical influence of massage the veins and the lymphatic vessels are emptied rhythmically and that the centripetal flow is assisted by the stroking and kneading applications directed toward the heart.[7] Less evident, however, and less simple in its mechanism is the reaction of the arterial and arteriolar system to massage. As regards this point, relatively few experimental data have been produced so far, and the statements of the authors have remained in most instances of a general character.

Kleen[8] stated that as a result of massage the arterial circulation was hastened by the quicker outflow from the veins and the diminished pressure within them. Kovács[9] stated that after massage there was an active hyperemia in the skin and the muscles and that the number of erythrocytes in the superficial vessels increased 40 to 50 per cent. Mennell[10] saw in the production of histamine or a histamine-like substance within the skin the explanation for the vasodilatation produced by massage; not only the surface of the skin was affected by stimulating massage, according to Mennell, but also all the tissues beneath it, particularly the smaller arteries and the arterioles.

Despard[11] expressed the belief that massage accelerated the flow of blood through the vascular system and increased the amount of blood in the part under treatment as a result of direct pressure and of stimulation of the vasomotor nerves. Skull[12] observed a definite peripheral vasodilatation together with an increase in the rate of peripheral blood flow after general massage.

5. Drinker, C. K.: The Formation and Movements of Lymph, Am. Heart J. **18**:389 (Oct.) 1939.
6. Bauer, Walter; Short, C. L., and Bennett, G. A.: The Manner of Removal of Proteins from Normal Joints, J. Exper. Med. **57**:419 (Mar. 1) 1933.
7. Krusen, F. H.: Physical Medicine; the Employment of Physical Agents for Diagnosis and Therapy, Philadelphia, W. B. Saunders Company, 1941, p. 526.
8. Kleen, E. A. G.: Massage and Medical Gymnastics, New York, William Wood & Company, 1921, p. 42.
9. Kovács, Richard: Electrotherapy and Light Therapy with Essentials of Hydrotherapy and Mechanotherapy, ed. 5, Philadelphia, Lea & Febiger, 1945, p. 406.
10. Mennell, J. B.: Physical Treatment by Movement, Manipulation and Massage, ed. 5, Philadelphia, The Blakiston Company, 1945, p. 49.
11. Despard, L. L.: Textbook of Massage and Remedial Gymnastics, ed. 2, London, Oxford University Press, 1920, p. 211.
12. Skull, C. W.: Massage — Physiologic Basis, Arch. Phys. Med. **26**:159 (Mar.) 1945.

In his opinion, it was not unlikely that the release of acetylcholine might play an intermediate role in the vasodilatation connected with massage. The massive redistribution of blood which takes place might involve removal of blood otherwise stagnating within the splanchnic and other regions. According to Crisp,[13] the only effects produced by massage were reflex or mechanical and deep massage increased the circulation in the limbs mechanically. Cooksey[14] defined three types of massage, each of which has its own use and purpose: (1) sedative massage, which is used to relax muscle spasm for the relief of pain; (2) stimulating massage, which is used to produce local hyperemia or to assist the venous return, and (3) specialized manipulations for specific purposes.

Leroy[15] remarked that deep stimulating massage acts as a succession of traumatisms and can be used selectively in order to stimulate the sensitive endings of the nerves and to produce vasodilatation by means of axon reflexes and release of histamine.

Three of us and an associate[16] previously reported that massage of the extremities resulted in an elevation of the cutaneous temperatures of varying degrees. This rise is probably due to an increased blood flow to the parts being treated. In most cases, it was impossible to determine how much of the rise in cutaneous temperature was due to mechanical effect on the blood flow and how much might have been due to reflex stimulation. In most instances the rise of temperature was only a few degrees centigrade, and the temperatures returned to basal levels in from ten to ninety minutes. In that study, massage of the back was done on 3 subjects, and no change of the cutaneous temperatures of the extremities was noted.

The purpose of the present study was to determine the effects on the blood flow in the extremities resulting from the standard deep stroking and kneading massage and also from vigorous, stimulating, kneading and percussion type of massage.

Methods

1. *The Determination of Blood Flow.* — The blood flow measurements were made by means of venous occlusion plethysmographs with the compensating spirometer recorder, as described by Berry and associates.[17] The arms were inserted into the plethysmographs up to 1 inch (about 2.5 cm.) above the olecranon process and the legs up to 1 inch below the tibial tuberosity. The apparatus consisted of two plethysmographs — the true plethysmograph and the blank — placed one on each of the extremities. Each plethysmograph was connected to a spirometer for volume recording. When both plethysmographs and spirometers are all functioning as a unit, a nicely compensating mechanism eliminates errors produced by changes in room temperature and pressure.

The compensating mechanism has been described in detail in another communication.[17] The plethysmograph is made airtight over the limb without any interference with the circulation. This is done by placing a thin sleeve of rubber dam over the arm, which is coated with surgical jelly above the elbow. The sleeve is everted over a diaphragm of sponge rubber. The limb is introduced into the plethysmograph, and the diaphragm is clamped by a metal ring to the border of the plethysmograph, thus making an airtight compartment over the forearm 1 inch above the elbow and communicating with the spirometers by means of a wide bore tubing. A blood pressure cuff, 5 cm. wide and connected to a reservoir of air under a pressure of 50 to 60 mm. of mercury, is wrapped around the part of the area proximal to the true plethysmograph.

13. Crisp, E. J.: Massage and Exercises in the After-Treatment of Fractures, M. Press **210**:329 (Nov. 24) 1943.
14. Cooksey, F. S.: The Value of Massage in Medical Diseases, M. Press **210**:331 (Nov. 24) 1943.
15. Leroy, Raoul: Le vie du tissu conjonctif et sa défense par le massage, Rev. de méd., Paris **58**:212, 1941.
16. Martin, G. M.; Roth, Grace M.; Elkins, E. C., and Krusen, F. H.: Cutaneous Temperature of Extremities of Normal Subjects and of Patients with Rheumatoid Arthritis, Arch. Phys. Med. **27**:665 (Nov.) 1946.
17. Berry, M. R.; Bahles, E. J.; Essex, H. E., and Wakim, K. G.: A Compensating Plethysmokymograph for Measuring Blood Flow in Human Extremities, J. Lab. & Clin. Med. **33**:101 (Jan.) 1948.

When this cuff is suddenly inflated to a pressure of about 50 mm. of mercury, well below diastolic pressure but above venous pressure, it traps the blood in the limb until the venous pressure exceeds the pressure in the cuff. For several seconds after the "collecting cuff" has been suddenly inflated, the volume of the limb increases because of hindrance of venous outflow without interference with arterial inflow into the limb.

In principle, the amount of blood flowing into the extremity is measured by determining the rate of increase of volume subsequent to the obstruction to venous outflow in the limb. The recordings were made of the blood flow in each limb before and after the massage procedures. The detailed description of the shape of the flow curve has been given in a previous report.[18]

These studies were carried out in a constant temperature room, maintained at 78 F., with a relative humidity of 40 per cent. Control blood flow readings were made with the patient lying on a comfortable bed for about thirty minutes after the plethysmographs had been applied to the extremities. After the establishment of the control blood flow, the extremities were removed from the plethysmographs and one of the extremities was massaged for fifteen or twenty minutes. After the massage, the extremities were again introduced into the plethysmographs, and a new series of blood flow measurements were taken. In a certain number of cases, another determination was made thirty minutes after the end of the massage period. During the interval, the plethysmographs were removed or widely opened and the subject remained quiet on the test bed. In 11 observations blood cell counts were made on blood collected immediately before and after massage from the big toe of the treated leg.

2. *Types of Massage.* — Two methods of massage were used in this study: The first was a modified Hoffa type of massage, employing deep stroking and kneading of the extremities, following the pattern of the large muscle groups. Massage of each extremity lasted for fifteen minutes. It was administered by physical therapy technicians, all of whom had been trained in the same basic technic. The stroking and kneading were made at a uniform rate. The massage was primarily centripetal in direction. In each instance it was begun and completed with deep stroking of the entire extremity. A light mineral oil was used as lubricant. The second type of massage employed in this study was a vigorous, forceful, stimulating massage, employing extremely deep stroking, kneading and friction. The massage was applied to the upper extremities for a period of fifteen minutes and included the anterior and posterior aspects of the arm, the forearm, the hand and the fingers. The lower extremities were massaged similarly for a period of twenty minutes, and this massage included the lower third of the thigh, the leg, the foot and toes (anterior and posterior aspects). This second type of massage was administered by a physician (J. C. T.) trained in the methods of stimulating massage employed in some of the European schools of physical therapy and massage.

3. *Subjects Used.* — The subjects who volunteered for this study included (1) a group of normal men and women; (2) a number of patients who had rheumatoid arthritis; (3) several patients who had flaccid paralysis of the lower extremities due to poliomyelitis and peripheral nerve injuries, and (4) a few patients who had a spastic type of paralysis due to various types of lesions of upper motor neurons occurring either in the cord or in the higher centers.

Results

1. *Effects of Vigorous, Stimulating Massage.* — Twelve sessions of vigorous, stimulating massage were given to the upper extremities and 14 sessions to the lower extremities of 15 normal subjects. Seven sessions were given to flaccid paralyzed lower extremities of 2 patients who had had poliomyelitis.

We consider as significant changes in blood flow those exceeding 15 per cent; as slight, the changes between 10 per cent and 15 per cent, and as insignificant, the changes less than 10 per cent.

Tables 1, 2 and 3 give detailed data on the control blood flow and the changes in blood flow observed in both extremities after vigorous, deep, stimulating massage of one extremity.

18. Wakim, K. G.; Krusen, F. H., and Elkins, E. C.: Effects of Artificially Induced Fever on the Circulation in Arthritic Patients, Arch. Phys. Med. 29:274 (May) 1948.

Table 1 shows that in the massaged normal upper extremities there was a significant increase in blood flow in 11 of 12 observations (maximal increase +119 per cent) and no significant change in 1 observation (+1 per cent). Table 2 shows that in the massaged normal lower extremities, there was a significant increase in 11 of 14 observations (maximal increase +153 per cent), no significant change in 2 observations (+1 per cent and 0 per cent)

TABLE 1. — *Blood Flow in Both Upper Extremities of Normal Subjects Before and After Vigorous, Stimulating Massage of One Extremity.*

Observation Number	Blood Flow in Massaged Extremity — Before Massage		After Massage		Difference		Blood Flow in Unmassaged Extremity — Before Massage		After Massage		Difference	
	Cc./Min.	Cc./100 Cc./Min.	Cc./Min.	Cc./100 Cc./Min.	Cc./Min.	%	Cc./Min.	Cc./100 Cc./Min.	Cc./Min.	Cc./100 Cc./Min.	Cc./Min.	%
1	79	4.4	150	8.3	+71	+90	99	5.5	104	5.8	+5	+5
2	140	7.8	141	7.8	+1	+1	108	6.0	86	4.8	—22	—20
4	77	4.3	102	5.7	+25	+32	60	3.3	68	3.8	+8	+13
6	92	5.1	177	9.9	+85	+92	81	4.5	78	4.3	—3	—4
7	113	6.6	186	10.9	+73	+65	78	4.6	63	3.7	—15	—19
8	113	6.3	134	7.5	+21	+19	123	6.8	92	5.1	—31	—25
9	74	4.1	147	8.2	+73	+99	84	4.7	68	3.8	—16	—19
10	99	4.3	138	6.0	+39	+39	131	5.7	71	3.1	—60	—46
25	69	3.7	128	6.9	+59	+86	60	3.2	77	4.2	+17	+28
40	56	5.6	87	8.7	+31	+55	60	6.0	48	4.8	—12	—20
42	63	3.6	138	7.9	+75	+119	87	5.0	122	7.0	+35	+40
43	93	5.5	149	8.8	+56	+60	84	4.9	116	6.8	+32	+38
Average	89	5.1	140	8.1	+51	+57	88	5.0	83	4.8	—5	—6
Range												
From	56	3.6	87	5.7	+1	+1	60	3.2	48	3.1	—60	—46
To	140	7.8	186	10.9	+85	+119	131	6.8	122	7.0	+35	+40

TABLE 2. — *Blood Flow in Both Lower Extremities of Normal Subjects Before and After Vigorous, Stimulating Massage of One Extremity.*

Observation Number	Blood Flow in Massaged Extremity — Before Massage		After Massage		Difference		Blood Flow in Unmassaged Extremity — Before Massage		After Massage		Difference	
	Cc./Min.	Cc./100 Cc./Min.	Cc./Min.	Cc./100 Cc./Min.	Cc./Min.	%	Cc./Min.	Cc./100 Cc./Min.	Cc./Min.	Cc./100 Cc./Min.	Cc./Min.	%
11	38	1.5	96	3.7	+58	+153	57	2.2	41	1.6	—16	—28
12	80	3.1	81	3.1	+1	+1	65	2.5	72	2.8	+7	+11
13	77	2.0	125	3.1	+48	+62	77	2.0	83	2.2	+6	+8
14	75	2.0	65	1.7	—10	—13	80	2.1	50	1.3	—30	—38
15	51	2.1	59	2.4	+8	+16	43	1.8	33	1.4	—10	—23
16	77	2.0	110	2.9	+33	+43	106	2.8	93	2.4	—13	—12
17	57	1.6	121	3.5	+64	+112	87	2.5	59	1.7	—28	—32
18	83	2.4	98	2.8	+15	+18	65	1.9	45	1.3	—20	—31
19	42	1.4	42	1.4	0	0	66	2.3	54	1.9	—12	—18
21	74	2.6	119	4.1	+45	+61	71	2.5	60	2.1	—11	—15
33	96	3.1	135	4.4	+39	+41	74	2.4	63	2.0	—11	—15
46	78	2.4	122	3.8	+44	+56	63	2.0	63	2.0	0	0
47	45	1.4	60	1.8	+15	+33	44	1.3	39	1.2	—5	—11
48	56	1.9	84	2.8	+28	+50	59	2.0	42	1.4	—17	—29
Average	66	2.1	94	3.0	+28	+42	68	2.2	57	1.8	—11	—16
Range												
From	38	1.4	42	1.4	—10	—13	43	1.3	33	1.2	—30	—38
To	96	3.1	135	4.4	+64	+153	106	2.8	93	2.8	+7	+11

and a slight decrease in 1 (—13 per cent). Table 3 shows that the blood flow in the massaged paralyzed extremities increased in all 7 observations (maximal increase +213 per cent). The average change in blood flow after vigorous stimulating massage was +57 per cent in the massaged normal upper extremities, +42 per cent in the massaged normal lower extremities and +103 per cent in the massaged paralyzed lower extremities.

The changes in blood flow in the contralateral (not massaged) extremities averaged —6 per cent for the normal upper extremities, with a range from —46 per cent to +40 per cent. The change in blood flow in the contralateral untreated normal lower extremities averaged —16 per cent, with a range

TABLE 3. — *Blood Flow in Both Lower Extremities of Subjects with Flaccid Paralysis Before and After Vigorous, Stimulating Massage of One Extremity.*

Observation Number	Blood Flow in Massaged Extremity						Blood Flow in Unmassaged Extremity					
	Before Massage		After Massage		Difference		Before Massage		After Massage		Difference	
	Cc./Min.	Cc./100 Cc. Min.	Cc./Min.	Cc./100 Cc. Min.	Cc./Min.	%	Cc./Min.	Cc./100 Cc. Min.	Cc./Min.	Cc./100 Cc. Min.	Cc./Min.	%
22	51	2.3	150	6.7	+99	+194	27	1.2	29	1.3	+2	+7
24	39	1.7	87	3.9	+48	+123	39	1.7	30	1.3	—9	—23
28	45	1.2	141	3.9	+96	+213	48	1.3	32	0.9	—16	—33
29	38	1.7	54	2.4	+16	+42	29	1.3	26	1.2	—3	—10
30	89	2.4	152	4.2	+63	+71	170	4.7	98	2.7	—72	—42
31	87	2.4	165	4.6	+78	+90	106	2.9	108	3.0	+2	+2
36	83	2.3	131	3.6	+48	+58	110	3.0	107	2.9	—3	—3
Average	62	2.0	126	4.2	+64	+103	76	2.3	61	1.9	—15	—20
Range												
From	38	1.2	54	2.4	+16	+42	27	1.2	26	0.9	—72	—42
To	89	2.4	165	6.7	+99	+213	170	4.7	108	3.0	+2	+7

from —38 to +11 per cent. In the paralyzed extremities, the average change in blood flow in the unmassaged contralateral extremities was —20 per cent, with a range from —42 to +7 per cent.

In 13 of the foregoing observations, the rate of blood flow was determined again thirty minutes after the end of the sessions of vigorous, deep, stimulating massage. This was done in 5 observations on normal upper extremities, in 5 on normal lower extremities and in 3 on paralyzed lower extremities. There was still a significant increase in blood flow over the controls in the treated extremity in all but 1 of the 13 observations. Thirty minutes after the massage the increase in blood flow over the control in the massaged normal upper extremities averaged +74 per cent, with a range from +11 to +139 per cent. In the normal lower extremities it averaged +61 per cent, with a range from +16 to +156 per cent. In the 3 paralyzed extremities, thirty minutes after the massage the increases in flow were +72, +165 and +150 per cent, respectively.

2. *Effects of Stroking and Kneading Massage.* — The modified Hoffa type of deep stroking and kneading massage produced much less change in the circulation of the massaged extremity than the vigorous stimulating massage; in 32 normal upper extremities this type of massage produced an average increase of only 4 per cent in blood flow, as compared with an increase of 57 per cent produced by vigorous stimulating massage. Instead of detailed tables the data on the subjects who were given stroking and kneading massage are analyzed in groups, according to the degree of change in blood flow in the extremities rather than individually. Before massage the blood flow in the 32 normal upper extremities averaged 111 cc. per minute, with a range from 24 to 183 cc. Calculated in terms of blood flow per hundred cubic centimeters of limb volume per minute, the flow averaged 6.0 cc., with a range from 2.0 to 9.4 cc. After the massage the blood flow averaged 115 cc., with a range from 27 to 224 cc. per minute; per hundred cubic centimeters of limb volume per minute the flow averaged 6.3 cc., with a range from 2.0 to 11.2 cc. The change of blood flow ranged from —56 to +54 per cent. Of

the 32 massaged normal upper extremities, 10 showed a significant increase in blood flow, 6 showed a significant decrease and in 16 the change was insignificant. In the unmassaged contralateral upper extremity, 4 showed a significant increase, 15 showed a significant decrease and 13 showed no significant change. The average change in blood flow in the unmassaged extremity was a decrease of 14 per cent. These results indicate that on the average only a slight increase in the blood flow in the extremity of a normal person follows deep stroking and kneading massage. This increase was not constant and is not considered to be significant.

In the lower extremities of 24 normal subjects before deep stroking and kneading massage the blood flow averaged 75 cc. per minute, with a range from 35 to 162 cc. per minute, and 2.7 cc., with a range from 1.2 to 5.2 cc., per hundred cubic centimeters of limb volume per minute. After massage the flow averaged 72 cc. per minute, with a range from 35 to 134 cc. per minute; per hundred cubic centimeters of limb volume per minute the flow averaged 2.6 cc., with a range from 1.2 to 4.3 cc. These changes represent an insignificant average decrease of 4 per cent in blood flow after the massage, with a range from —42 to +25 per cent. Of 24 normal lower extremities that were massaged, 5 showed a significant increase in blood flow, 4 a significant decrease and 15 no significant change. The blood flow in the contralateral unmassaged extremity showed an average decrease of 10 per cent after massage, which is not a significant change.

In the extremities of 6 patients who had flaccid paralysis of the lower extremities the blood flow before massage averaged 51 cc. per minute, with a range from 23 to 84 cc. per minute; per hundred cubic centimeters of limb volume per minute the flow averaged 1.7 cc., with a range from 1.2 to 2.3 cc. After massage the flow averaged 62 cc. per minute, with a range from 26 to 94 cc.; per hundred cubic centimeters of limb volume per minute it averaged 2.1 cc., with a range from 1.5 to 2.8 cc. In other words, there was an average increase in blood flow of 22 per cent, with a range from +2 to +97 per cent, in the flaccid extremities after deep stroking and kneading massage. There was an average decrease of 8 per cent in the blood flow of the unmassaged contralateral extremities. These findings indicate that the effect of deep stroking and kneading massage on the blood flow in the extremity with flaccid paralysis is more marked than the changes observed in the normal. In 4 of 6 observations in this group there was a significant increase in the blood flow after the massage, and in 2, an insignificant increase.

The average changes in the blood flow after deep stroking and kneading massage of the upper and lower extremities of patients with spastic paralysis or paresis were as follows: Before massage the total blood flow averaged 66 cc. per minute, with a range from 25 to 150 cc., in the spastic upper extremities, and 35 cc. per minute, with a range from 18 to 60 cc. in the lower extremities; per hundred cubic centimeters of limb volume per minute the flow averaged 4.9 cc., with a range from 2.8 to 9.4 cc., in the upper extremities and 2.2 cc. with a range from 1.2 to 3.5 cc., in the lower extremities. After massage the flow averaged 69 cc. per minute, with a range from 44 to 116 cc., in the upper extremities and 40 cc. per minute, with a range from 24 to 61 cc., in the lower extremities. Calculated on a percentage basis, this means that massage of the upper extremities produced an average increase of 5 per cent in the blood flow. In the unmassaged contralateral upper extremities there was an average decrease of 18 per cent in blood flow. Of 5 spastic upper extremities that were massaged, 3 showed a significant increase, 1 a significant decrease and 1 no significant change in blood flow. After massage of the lower extremities there

was an average increase of 14 per cent in the blood flow of the massaged extremities and a decrease of 25 per cent in the unmassaged lower extremities of the subjects with spastic paralysis. Two of the 5 spastic lower extremities which were massaged showed a significant increase in blood flow, whereas 3 showed no significant change. The changes in blood flow in the spastic extremities after deep stroking and kneading massage corresponds very closely with the changes observed in the normal subjects after the same type of massage.

In patients with rheumatoid arthritis the total blood flow per minute before deep stroking and kneading massage averaged 119 cc., with a range from 50 to 297 cc., in the upper extremities, and 71 cc., with a range from 40 to 124 cc., in the lower extremities. Per hundred cubic centimeters of limb volume per minute the flow averaged 6.0 cc., with a range from 3.0 to 14.3 cc., in the upper extremities and 2.8 cc., with a range from 1.7 to 4.2 cc., in the lower extremities. After massage the flow per minute averaged 121 cc., with a range from 71 to 211 cc., in the massaged upper extremities. Expressed per hundred cubic centimeters of limb volume per minute, this flow was 6.2 cc., with a range from 3.4 to 10.1 cc. After massage of the lower extremities the blood flow per minute in the massaged extremities averaged 69 cc., with a range from 47 to 98 cc., or 2.8 cc. per hundred cubic centimeters of limb volume per minute, with a range from 2.0 to 4.6 cc. Expressed in percentage, the upper extremities showed an average increase of 2 per cent, with a range from —35 to +74 per cent, and the lower extremities showed an average decrease of 3 per cent in blood flow, with a range from —23 to +53 per cent, after the deep stroking and kneading massage. These average changes in the massaged extremities are insignificant. However, considered individually, 5 of 11 upper extremities showed a significant increase, 2 showed a significant decrease and 4 showed no significant change; while 4 of 11 lower extremities showed a significant increase in blood flow, 4 showed a significant decrease and 3 showed no significant change. These results are comparable to those observed after the same type of massage of the extremities of normal subjects. It is also interesting to note that the average blood flow before the massage in both the upper and the lower extremities of patients who had rheumatoid arthritis was approximately the same as in the normal subjects who were given deep stroking and kneading massage.

TABLE 4. — *Summary of Effects of Massage on Peripheral Blood Flow.*

Condition of Extremity	Extremity	Type of Massage	Total Subjects	Subjects Showing Significant Increase of Blood Flow	Average Percentage Change of Blood Flow
Normal	Upper	Deep stroking and kneading	32	10	+4
	Lower	Deep stroking and kneading	24	5	—4
Flaccid	Lower	Deep stroking and kneading	6	4	+22
Spastic	Upper	Deep stroking and kneading	5	3	+5
	Lower	Deep stroking and kneading	5	2	+14
Rheumatoid arthritis	Upper	Deep stroking and kneading	11	5	+2
	Lower	Deep stroking and kneading	11	4	—3
Normal	Upper	Vigorous, stimulating	12	11	+57
	Lower	Vigorous, stimulating	14	11	+42
Flaccid	Lower	Vigorous, stimulating	7	7	+103

Table 4 summarizes the data obtained on the effects of deep stroking and kneading massage and of vigorous, stimulating massage. It is clearly demonstrated that the former type of massage produced comparatively slight, and in most groups insignificant, changes in the circulation of the massaged

extremity, whereas the vigorous, stimulating type of massage gave a significant increase in the circulation of the massaged extremity.

The counts of erythrocytes, total leukocytes and lymphocytes were made before and after vigorous, stimulating massage of the extremity in 11 subjects.

TABLE 5. — *Effect of Massage on the Blood Cell Counts.*

Observation Number	Erythrocytes, Millions Per Cu. Mm.			Leukocytes, Thousands Per Cu. Mm.			Lymphocytes, Cells Per 100 Leukocytes		
	Before	After	Difference	Before	After	Difference	Before	After	Difference
15	3.94	5.22	+1.28	3.1	6.9	+3.8	62	65	+3
16	4.38	4.64	+0.26	6.1	6.3	+0.2	22	18	—4
17	3.97	4.45	+0.48	7.5	4.3	—3.2	34	42	+8
18	4.21	4.78	+0.57	3.6	6.1	+2.5	36	42	+6
19	4.53	4.31	—0.22	5.4	4.7	—0.7	48	44	—4
20	4.04	4.69	+0.65	2.5	4.5	+2.0	37	45	+8
21	5.67	4.89	—0.78	7.9	8.9	+1.0	24	23	—1
22	4.18	4.45	+0.27	4.8	6.7	+1.9	47	32	—15
23	4.13	4.63	+0.50	5.9	4.9	—1.0	36	43	+7
28	4.70	4.77	+0.07	10.9	6.7	—4.2	22	19	—3
48	4.21	4.40	+0.19	5.2	4.7	—0.5	39	32	—7

Table 5 gives the data in detail for each subject. Nine of the 11 subjects showed an increase in the erythrocyte count as a result of the massage. Of these 9 subjects, 4 showed each an increase of 500,000 or more erythrocytes per cubic millimeter of blood and 5 had an increase of less than 500,000 each. In the remaining 2 subjects there was a decrease of the erythrocyte count after massage. The changes in the total leukocyte counts and in lymphocytes were variable and inconsistent.

Comment

Analysis of the data obtained in this study indicates that deep stroking and kneading massage of either upper or lower extremities produces more or less moderate and often insignificant change in blood flow when compared with vigorous, stimulating massage. In subjects who had flaccid paralysis, deep kneading and stroking massage of the involved extremities seems to produce a significant increase of blood flow of the massaged extremity.

The vigorous, stimulating massage, as applied to the upper and lower extremities of normal subjects and to the lower extremities of patients who had flaccid paralysis, produced significant increases in the blood flow in 29 of the 33 massaged extremities. The average increase in blood flow was most marked in the extremities with flaccid paralysis. However, definite and significant increases in blood flow were also noted after the massage of normal extremities. Although this type of vigorous, stimulating massage results in a marked increase in peripheral blood flow in the extremities, it is not a type of massage that can be used routinely as a therapeutic procedure for treating most patients seen in a department of physical medicine. This type of massage can be traumatizing to flaccid muscles and other soft tissues if administered indiscriminately.

Summary and Conclusions

The effects of vigorous, stimulating massage and of a modified Hoffa type of deep stroking and kneading massage on the peripheral circulation in normal and diseased extremities were studied by means of the venous occlusion plethysmograph with the compensating spirometer recorder. The data obtained justify the following conclusions:

1. There is no consistent or significant average increase in total blood flow after deep stroking and kneading massage of the extremities, in normal subjects, in those with rheumatoid arthritis or in those with spastic paralysis of the extremities.

2. There is a moderate, consistent and definite increase in circulation after deep stroking and kneading massage to the extremities of subjects who have flaccid paralysis.

3. Vigorous, stimulating massage results in consistent and significant increases in the average blood flow of the massaged extremity.

4. Neither deep stroking and kneading massage nor vigorous, stimulating massage of the extremities results in consistent or significant changes in the blood flow of the contralateral unmassaged extremities.

Discussion

Dr. Dean M. Hayes (Washington, D. C.): It is difficult to discuss such a complete report. Many of the claims which we have made for various forms of therapy which have been accepted as fact have not been substantiated by careful research.

This report has clarified the question of the therapeutic value of deep kneading and stroking massage on the blood flow of the extremities in the four categories studied. It should not be inferred from this paper that therapeutic massage is of no value.

I should like to ask Dr. Martin to explain more fully the vigorous stimulating kneading and percussion massage used in this study.

The authors of this paper are to be commended for their careful research. There is certainly a great need for such complete and painstaking study and findings.

Dr. Ferdinand Schwartz (Birmingham, Ala.): I should like to ask Dr. Martin the difference between mechanical massage and manual massage in regard to blood flow.

Dr. Martin (closing): I appreciate Dr. Hayes' emphasis of the fact that, since we have not found as extensive increases in blood flow as we might have anticipated from analysis of the literature, this does not mean that massage is not a useful therapeutic procedure. I think that we merely have a few more data on the extent of the effect of manual massage on the peripheral blood flow.

Dr. Hayes requested further details regarding the stimulating massage. This stimulating massage was a very vigorous forceful massage administered by a young muscular physician, who had been trained and had experience in some of the European schools of massage. The massage included a deep stroking, a very deep forceful kneading of the tissues, plus the use of deep friction. This massage was given to the extremity for fifteen to twenty minutes. Mineral oil was used as a lubricant. The skin was usually hyperemic at the conclusion of the massage procedure. This is certainly not a type of massage which would be indicated therapeutically in the cases seen in most departments of physical medicine. Merely the fact that we obtained our greatest improvement in circulation with this vigorous stimulating massage does not imply that this is an acceptable routine technic. This study provides only an experimental evaluation of the effect of this type of massage on the circulation.

We have done no studies using any mechanical massage devices. That is something which perhaps could be considered in some separate and later studies. All massage procedures were done manually and were administered by physical therapists or the physician trained in massage methods.

SOME BIOLOGIC ASPECTS OF ULTRASONICS *

J. F. HERRICK, Ph.D.

Division of Experimental Medicine, Mayo Foundation

ROCHESTER, MINN.

The term "ultrasonic" (beyond sound) is self defining. Just as we find a particular portion of the electromagnetic spectrum characterized by the terms "infra-red," "visible" (red, orange, yellow, blue, indigo and violet) and "ultraviolet," so we find the acoustic spectrum described similarly as "infrasonic," "sonic" and "ultrasonic." What is ultrasonic to one human ear may be sonic (audible) to another. For this reason the limits of audibility are not fixed. Arbitrarily one may consider any frequency of more than 20,000 cycles per second as ultrasonic. The ultrasonic portion of the acoustic spectrum does not possess characteristics unusual to those of the familiar sonic portion. The mode of propagation, the velocity and other characteristics are the same. As the frequency increases, the wavelength becomes smaller, because the product of frequency and wavelength equals the velocity of the acoustic wave in any given medium. At very high frequencies the wavelengths become of the same order of magnitude as those for visible light. At these frequencies certain optical-like characteristics appear. Ultrasonic waves can be focused more easily, and the path of propagation becomes more nearly rectilinear.

Modern ultrasonics was born when Langevin[1] took it from the academic laboratory and made a practical application of it. He did this about 1917 when developing submarine transmitters and receivers at the Toulon Arsenal.

The development of ultrasonic generators (transmitters) and detectors (receivers) by Langevin and others is an intensely interesting subject.[2] It will be treated only very briefly in this paper. Perhaps the ultrasonic generators occurring in nature are even more interestng than the generators made by man.[3] Most remarkable of nature's high frequency transmitters observed thus far is that of the bat.[4] The bat guides itself during flight by generating high frequency pulses, as high as 70,000 cycles per second, which are reflected by obstacles. The bat also has the ability to receive these pulses and thereby avoid the obstacle reflecting them. This transmitting and receiving equipment possessed by the bat reminds one of that important wartime development known as sonar (sound navigation and ranging). The ultrasonic generators which occur in nature have relatively small outputs. The study of the biologic aspects of ultrasonics often requires man-made generators having outputs of a few hundred watts. A generator which is very satisfactory for many practical applications makes use of the piezoelectric crystal. These crystals vibrate mechanically when an oscillating electric field is applied to them. The quartz vibrates with greatest amplitude when the frequency of the electric oscillations is the same as its own natural frequency of oscillation. Two other commercial methods for generating ultrasonics depend on magnetostriction and the air jet, respectively.

* Read at the Twenty-Sixth Annual Session of the American Congress of Physical Medicine, Washington, D. C., Sept. 9, 1948.

1. Langevin, P.: Quoted by Wood, R. W.: In Supersonics, The Science of Inaudible Sounds, Providence, R. I., Brown University, 1939. Langevin, M. P., and Chilowsky, M. C.: Quoted by Bergmann.6

2. Klein, Elias: Some Background History of Ultrasonics, J. Acoustic. Soc. America **20**:701 (Sept.) 1948.

3. Pielemeier, W. H.: Supersonic Insects, J. Acoustic. Soc. America **17**:337 (Apr.) 1946.

4. Hartridge, H.: Acoustic Control in the Flight of Bats, Nature **156**:490 (Oct. 27) 1945. Galambos, Robert: The Avoidance of Obstacles by Flying Bats: Spallanzani's Ideas (1794) and Later Theories, Isis **34**:132, 1942; Flight in the Dark: A Study of Bats, Sc. Monthly **56**:155 (Feb.) 1943. Galambos, Robert, and Griffin, D. R.: Obstacle Avoidance by Flying Bats: The Cries of Bats, J. Exper. Zool **89**:475 (April) 1942.

One finds that up to the present time the terms "ultrasonics" and "supersonics" have been used interchangeably in the literature. However, recently the aeronautic engineers have adopted the term "supersonics" to denote velocities greater than those of sound. This leaves the term "ultrasonics" for indicating frequencies higher than those audible to the human ear.

When reviewing the literature on the biologic effects of ultrasonics, one becomes confused because the effects cover the entire range of possibilities — from no effect through a stimulating effect to a destructive or even lethal effect. This state of affairs is characteristic when one is studying the effects of new types of radiation before dosages can be measured accurately and thus before standards can be definitely determined. The measurement of ultrasonic energy is particularly difficult. The unit of sound intensity is the decibel — one-tenth of the bel, named in honor of Alexander Graham Bell. The threshold of audibility is 10^{-16} watts per square centimeter. This corresponds to the faintest audible whisper and may be considered as approximately 0 decibel. Ordinary conversation has a loudness level of 60 decibels, or 10^{-10} watts per square centimeter. A painful sound may be 120 decibels, or 10^{-4} watts per square centimeter. A group[5] at Pennsylvania State College who studied the effect of air-borne sounds on small animals stated their intensity as 160 to 165 decibels.

Before the biologic effects of ultrasonics are discussed it might be well to recall a few important characteristics of acoustic waves. One cannot be expected to appreciate the effects of ultrasonics unless one understands the mechanism of propagation of sound energy. Unlike electromagnetic waves, the sound wave, whether it is audible or not, requires a material medium for its propagation. The velocity of propagation depends on the elasticity and the density of the particular medium. Sound waves (in fluid mediums) are longitudinal, whereas electromagnetic waves are transverse. In a longitudinal wave the elementary particles of the propagating medium are vibrating in paths parallel to the direction of propagation. Such a type of wave contains rarefactions and condensations alternately. The presence of these rarefactions and condensations gives rise to great alternations in pressure, the frequency of these alternations in pressure being the same as the frequency of the given wave. The pressures developed may be as great as several atmospheres. This condition causes great forces to act for very brief periods, thereby causing accelerations which may be of the order of magnitude of 10^6 times that of gravity. An appropriate description of this condition has been given as "all acceleration and no motion." Empty spaces relatively large in comparison with the structural units of the medium are produced by acoustic waves. These empty spaces are called "cavitations." Cavitations may give rise to violent explosions within minute volumes of the propagating medium. The mechanical forces accompanying pressure alternations and cavitations play the major role in producing the observed biologic effects. In addition to these mechanical effects, there are the thermal effects due largely to the absorption of the sound energy. Ultrasonics also accelerates many chemical processes, particularly oxidative processes. Depolymerization and liquefaction of thixotropic gels have been reported among the chemical effects of ultrasonics.

The present enthusism in ultrasonics is due in part to the recent achievements in high speed air navigation. It is possible now for certain aircraft to travel at speeds which approximate and even exceed the velocity of sound. The engines in such aircraft may generate very high acoustic frequencies.

5. Allen, C. H.; Frings, H., and Rudnick, I.: Some Biological Effects of Intense High-Frequency Airborne Sound, J. Acoustic. Soc. America 20:62 (Jan.) 1948.

One does not have to be in an aircraft traveling at these high speeds to experience ultrasonic irradiation. Personnel doing ground work in the vicinity of air jet-propelled engines may also be exposed to ultrasonics. Thorough investigations concerning the physiologic effects of ultrasonics is almost imperative if the effects of ultrasonic irradiations are to be recognized.

The results of many years of investigations on the biologic effects of ultrasonics show that they may be classified into three major groups: (1) mechanical effects, (2) thermal effects and (3) chemical effects. This classification tends to mask the dispersive, colloidal, coagulating and degassing effects of ultrasonics, which have found numerous applications in industry.[6]

The intrinsic characteristics of ultrasonic waves described previously leave little for one's imagination when attempting to understand the tremendous mechanical factors and their possible role in bringing about destructive effects. The phenomena accompanying cavitations are far from being completely understood. Animal tissues are literally torn into pieces. If one observes living cells under the microscope during ultrasonic irradiation, one may see whirling of the protoplasm, appendages being sheared off, filaments of spirogyra torn to pieces, laking of red corpuscles, paramecia rendered immobile and later torn open, and so forth.[7] However, if elementary structures are sufficiently small relative to the given wavelength used, they may be protected from damage if they are located at those points in the wave where destructive forces are minimal.

The thermal effects of ultrasonics may cause thermal deaths of animals. The source of the heat is due in a large measure to the absorption of the sound energy. Another source of the heat is the friction accompanying the mechanical forces. Frings, Allen and Rudnick[8] have an interesting report on the thermal effects of high frequency air-borne sound on animals and humans. The fur of mice reached temperatures as high as 93 C. (199.4 F.) and the body temperature rose as high as 60 C. (140 F.). These scientists experienced unusual heating between the fingers when they were placing and retrieving animals in the ultrasonic field. Slight dizziness and unusual fatigue were also experienced. This unusual fatigue is regarded with much concern. These experimental results emphasize something which cannot be overlooked — that ultrasonics is truly a death ray when sufficient outputs are available.

It is well known that ultrasonics produces chemical effects.[9] Most of the chemical reactions are oxidations. Harvey[7c] referred to cavitated oxygen in his papers. The explosive violence with which cavitations occur may bring about the dissociation of molecules. Of course, it is difficult to separate the purely chemical effects of ultrasonics from the thermal and mechanical effects. One interesting effect is the luminescence which is produced in certain liquids, particularly glycerin and nitrobenzene.[6] It has been shown that electrochemical effects take place. During electrolysis there may be periodic concentrations of charge in the path of propagation of the high frequency wave.

6. Bergmann, Ludwig: Ultrasonics and Their Scientific and Technical Applications (translated by H. S. Hatfield), John Wiley and Sons, Inc., New York, 1938, chap. 5, pp. 189-226.

7. (*a*) Harvey, E. N.; Harvey, Ethel B., and Loomis, A. L.: Further Observations on the Effect of High Frequency Sound Waves on Living Matter, Biol. Bull. **55**:459 (Dec.) 1928. (*b*) Wood, R. W., and Loomis, A. L.: The Physical and Biological Effects of High-Frequency Sound-Waves of Great Intensity, Philosoph. Mag. & J. Sc. **4**:417 (Sept.) 1927. (*c*) Harvey E. N.: Biological Aspects of Ultrasonic Waves: A General Survey, Biol. Bull. **59**:306 (Dec.) 1930. (*d*) Davis, Hallowell: Biological and Psychological Effects of Ultrasonics, J. Acoustic. Soc. America **20**:605 (Sept.) 1948.

8. Frings, Hubert; Allen, C. H., and Rudnick, Isadore: The Physical Effects of High Intensity Air-Borne Ultrasonic Waves on Animals, J. Cell. & Comp. Physiol. **31**:339 (June) 1948.

9. Richards, W. T., and Loomis, A. L.: The Chemical Effects of High Frequency Sound Waves: I. A Preliminary Survey, J. Am. Chem. Soc. **49**:3086 (Dec. 10) 1927. Richards, W. T.: The Chemical Effects of High Frequency Sound Waves: II. A Study of Emulsifying Action, J. Am. Chem. Soc. **51**: 1724 (June 5) 1929. Richards, W. T.: Supersonic Phenomena, Rev. Mod. Physics. **11**:36 (Jan.) 1939.

From the effects just reviewed one obtains the impression that ultrasonics is a dangerous agent. However, it has been demonstrated repeatedly in the history of medical science that what is harmful in large doses may be of great therapeutic and diagnostic value in smaller appropriate doses. The destructive mechanical effects may be subdued into a beneficial micromassage. This is essentially what may have been happening when Horwath[10] treated certain pathologic lesions or when Denier and others[11] treated neuralgia. The apparent removal of certain cutaneous malignant lesions by Horvath with his ultrasonic generator is most spectacular. If macromassage has proved to be so beneficial throughout its many years of use, surely this new tool for micromassage should be equally beneficial.

There is no need to dwell on the value of thermal effects. Freundlich, Söllner and Rogowski[12] proposed ultrasonic diathermy sixteen years ago. They have shown that bone marrow may be heated without effect on the bone itself. It may be possible through proper focusing of the ultrasonic waves to increase the intensity 150 times.[13] This may permit the heating of small, deeply seated regions without serious injury to the intervening tissues.

Practical applications of the chemical effects of ultrasonics in medical therapy are difficult to separate from those of thermal or mechanical effects. Certain chemical processes may be accelerated in vivo and thus bring about a necessary therapeutic procedure. Increase in intracellular metabolism due to ultrasonics has been described.[11d] The preparation of antigens and enzymes from bacteria in vitro by means of sonics and ultrasonics might be regarded as one type of valuable chemical therapy.[14]

Ultrasonotherapy is the relatively new term to indicate the use of ultrasonics in medical therapy. Those who read the "Year Books of Physical Medicine" will recall the reports of the work of Denier and other European physicians, who have treated neuralgia and other disorders with ultrasonics. Reports of therapeutic applications of ultrasonics appeared in the Year Books as early as 1939.

Ultrasonics may also prove to be a valuable tool for medical diagnosis. The use of ultrasonics for detecting flaws in metals is well established.[15] A new flaw detector developed by the General Electric Company is described briefly in a recent issue of *Science News Letter*.[16] Perhaps the flaw detectors used in industry can be adapted for the detection of "flaws" in the human patient. A description of Denier's ultrasonoscope may be found in the 1946 and 1947 "Year Books of Physical Medicine." Denier reported that he can locate tumors and pleural effusions with precision. Recently I had the opportunity to read an unpublished German paper in which the author also claimed that he could locate tumors by means of ultrasonics. He stated that

10. Horvath, J.: Ultraschallwirkung beim menschlichen Sarkom, Strahlentherapie **75**:119, 1944; Ueber die Wirkung der Ultraschallwellen auf das menschliche Karzinom, Klinik u. Praxis **1**: (Feb. 6) 1946; Weitere Erfahrungen über die Wirkung der Ultraschallwellen auf das menschliche Karzinom, ibid. **1**:106 (May) 1946. Dyroff, R., and Horvath, J.: Ultraschallwirkung beim menschlichen Sarkom, Strahlentherapie **75**:126, 1944.

11. (*a*) Denier, André: Ultra-sonothérapie et ultra-sonoscopie, Presse Méd. **2**:753 (Nov. 9) 1946; (*b*) Les ultra-sons: leurs applications au diagnostic: ultra-sonoscopie, et la thérapeutique ultra-sonothérapie, J. de radiol. et d'électrol. **27**:481 (June 25) 1946; (*c*) Ultra-sonoscopie: ultra-sonotherapie, ibid. **28**:250, 1947. (*d*) Pholmann, R.; Richter, R., and Parow, E.: Ueber die Ausbreitung und Absorption des Ultraschalls im menschlichen Gewebe und seine therapeutische Wirkung an Ischias und Plexusneuralgie, Deutsche med. Wchnschr. **1**:251 (Feb. 17) 1939.

12. Freundlich, H.; Söllner, K., and Rogowski, F.: Kurze wissenschaftliche Mitteilungen: Einige biologische Wirkungen von Ultraschallwellen, Klin. Wchnschr. **11**:1512 (Sept. 3) 1932.

13. Lynn, J. G.; Zwemer, R. L.; Chick, A. J., and Miller, A. E.: A New Method for the Generation and Use of Focused Ultrasound in Experimental Biology, J. Gen. Physiol. **20**:179 (Nov. 20) 1942.

14. Chambers, L. A., and Flosdorf, E. W.: Sonic Extraction of Labile Bacterial Constituents, Proc. Soc. Exper. Biol. & Med. **34**:631 (June) 1936. Stumpf, P. K.; Green, D. E., and Smith, F. W., Jr.: Ultrasonic Disintegration as a Method of Extracting Bacterial Enzymes, J. Bact. **51**:487 (April) 1946.

15. Firestone, F. A.: Supersonic Reflectoscope: an Instrument for Inspecting the Interior of Solid Parts by Means of Sound Waves, J. Acoustic. Soc. America **17**:287 (Jan.) 1946. Firestone, F. A., and Frederick, J. R.: Refinements in Supersonic Reflectoscopy: Polarized Sound, ibid. **18**:200 (July) 1946. Bergmann.[6]

16. Ultrasonic Sound Waves Detect Flaws in Metals, Science News Letter (Aug. 14) 1948, p. 100.

the resolving power with ultrasonics was greater than that with roentgen rays. This relatively new field of medical diagnosis may be called "ultrasonoscopy."

A group (C. F. Schlotthauer, W. A. Bennett, E. J. Baldes and I) at the Mayo Foundation has been studying the effects of ultrasonics on some malignant tumors of animals for the past few months. These studies were undertaken for the primary purpose of confirming if possible the results on malignant lesions published by Horvath, a German scientist working at Erlangen. We have an ultrasonic generator similar to the one used by Horvath. We are treating malignant tumors which occur spontaneously in the dog, transmissible tumors of the chick and transmissible mammary carcinomas of the mouse. Definite degenerative changes have followed ultrasonic irradiations. However, metastasis has proceeded in several of the treated animals and caused the death of these animals. Reliable reports of our investigations cannot be given until much more work has been completed.

Discussion

Dr. Curtis J. Humphreys (Washington, D. C.): The subject of ultrasonics was first brought to my attention twenty years ago in a lecture entitled "Sounds That Burn," by the distinguished experimental physicist, R. W. Wood, of Johns Hopkins University. At that early date many of the physical effects, for instance, heating, had been noted. Still earlier, Langevin had utilized the property of fluid transmission of these waves to construct a submarine-detecting device during the First World War.

These comments emphasize the role of the physicist in ultrasonic experiments. That role appears to be to provide accurate control data to insure the most effective use of the technic, to guard against extraneous effects and to protect both operators and subjects from possible injury.

Such control data should include: power or rate of energy dissipation in the ultrasonic beam, frequency, since the effects are rather specific with frequency, and transmissivity of the medium. That such data may be inadequate in biologic literature is illustrated by an otherwise excellent paper by Beckwith and Weaver, (J. Bacteriol. **32**, 1936). The paper deals with the lethal effects of ultrasonics on certain yeast cultures, colon bacilli, and other organisms. Although it was apparent that there was a close correlation between the killing of organisms and frequency, the largest — such as the yeast plants — being killed more readily, no such data were given. Furthermore, there was no information about the power used other than the statement that it was "large."

An extraneous effect first noted by Richards is the considerable dielectric loss heating, induced by electromagnetic waves from the generator. This effect should be distinguished from true ultrasonic heating.

Referring to the danger to personnel in the vicinity of ultrasonic generators, stressed by Dr. Herrick, a question of effective range is involved. Data are available, the ranges being much greater for solids and liquids than for gases. According to Bergmann's textbook on Ultrasonics, the ranges for reduction to half-intensity in air for appropriate frequencies are: 10 kilocycles, 220 meters; 100 kilocycles, 2.2 meters; 1,000 kilocycles, 2.2 centimeters. That is, an increase in frequency by a factor of 10 corresponds to a diminution in range by a factor of 100. For water the corresponding half-intensity values are 400 kilometers for 10 kilocycles, and 40 meters for 1,000 kilocycles, the appropriate factors still being the same. These data point to possible overemphasis on the danger mentioned.

ROUND TABLE DISCUSSION ON BIOPHYSICS

Do you want a round table discussion on biophyhics as a feature of our forthcoming Cincinnati session? Whether or not this will be planned depends on the demand. Please write the Central office as to what you would like discussed, who might be asked to participate in this discussion, and any other comments that would help the program committee to make a decision.

BRACHIAL NEURALGIA

JOHN SHULMAN, M.B., D. Phys. Med.

Physician in Charge, Department of Physical Medicine, Coventry and Warwickshire Hospital, and Department of Physical Medicine, Warneford Hospital, Leamington Spa

COVENTRY, ENGLAND

Medical knowledge of the causes of pain in the neck, shoulders and upper limbs has made tremendous strides in this generation. The old diagnostic labels of neuritis and fibrositis have long been superseded by mechanical conceptions, such as pressure effects of displaced spinal disks and other pressure effects on the neurovascular structures of the brachial plexus, such as occur in costoclavicular compression, in the scalene syndrome and in that form of acroparesthesia described by Walshe, LeVay and others.[1] In addition, the painful fatty herniations of the basic fat of the neck and shoulders described by Copeman and Ackerman[2] brought to our attention the problem of pain involving tissues hitherto ignored in our diagnostic thoughts. Moreover, the role of the sympathetic nervous system in the causation of pain must also to be considered—proximally by traction on the stellate ganglion and distally by ischemic changes affecting the insulating value of the sheaths of the sympathetic nerve fibers. In addition, Hoffman, in a recent review of the problem, described forty-three groups of possible causes of pain in the arm.

For the purpose of this paper, however, I shall confine my discussion to three causes of pain in the region between the neck and upper limbs: (1) pain associated with osteoarthritis of the costotransverse articulations of the first rib; (2) pain in the supraspinatus muscle; (3) pain associated with faults in the lower cervical portion of the spine.

Pain Associated with Osteoarthritis of the First Costotransverse Articulations

The articulations between vertebrae and ribs consist of two portions: (1) articulations of the head of the rib with the facets on the borders of the vertebrae, the costovertebral joints, and (2) acticulations between the tubercle of the rib and the transverse process of the first dorsal vertebra, the costotransverse joints. In examination of a large number of roentgenograms there appears to be a condition of these joints characterized by eburnation of the articular surfaces, loss of joint space, deformity of articular surfaces and sometimes osteophytic outgrowths.

The changes are sometimes found in both costovertebral and costotransverse joints, but they are more frequently well marked in the latter. They appear fairly frequently in cases of osteoarthritis of the cervical portion of the spine but often occur as a separate entity. They do not typically occur in polyarthritis of infective or of rheumatoid type, but both roentgenologically and clinically the condition appears to be osteoarthritic in character.

The diagnosis can be readily confirmed by deep pressure over the affected area, and often, during investigation, patients are able to describe with accuracy the location of pain to one or the other side of the spine of the first thoracic vertebra.

* Read at the Twenty-Sixth Annual Session of the American Congress of Physical Medicine, Washington, D. C., Sept. 10, 1948.

1. Walshe, F. M. R.; Jackson, Harvey, and Wyburn-Mason, R.: Brain **67**:141, 1945. Walshe, F. M. R.: Brit. J. Phys. Med. **2**:596, 1945. LeVay, A. D.: Lancet **2**:164, 1945.
2. Copeman, W. S. C., and Ackerman, W. L.: Quart. J. Med. **13**:37, 1944.

The question naturally arises, why should this particular joint be involved more frequently than any of the other costotransverse joints lower down? The answer may be suggested in the special anatomic formation and physiologic mechanism of the first rib. In the case of this rib, the costovertebral and costotransverse joints are so designed as to allow a fair amount of rotation to take place on the long axis of the rib. Moreover, this rib has attached to it the scalenus anticus and scalenus medius muscles, which act either by raising the thorax or by flexing and rotating the cervical part of the spine. In consequence, this first rib bears more stresses and strains than any of the other ribs, and these stresses and strains are at maximum intensity at the costotransverse joint. A possible additional factor in the pathologic process in the fact that this joint is relatively weaker than the costotransverse joints of the other ribs because it has no superior costotransverse ligament. Moreover, the joint is in close relationship to the corresponding intercostal vessels and nerves which cross it anteriorly; this fact may possibly explain symptoms of paresthesia of the inner aspect of the elbow and forearm of the affected side which sometimes occur in these cases (first dorsal dermatome).

Treatment of the conditions by short wave radiations or by other forms of heat is often very effective in alleviating pain, but I am hopeful that some of the newer physical modalities, such as microwave radiations, may be more effectively focused on the abnormal area.

Another question often raised is, why does deep inspiration not always cause pain in this condition? There are two possible explanations. 1. These changes occur in patients who are mostly in or past middle life and the range of respiratory movements is naturally less. 2. Osteoarthritic joints do not always give pain in every direction of movement. For instance, osteoarthritic hips are often painful only on rotation and not on flexion.

Whether breathing exercises would be an advantage or not in this condition is a debatable problem, as the advantage of increased mobilization of these joints may be counterbalanced by the disadvantage of forcing additional movements in a pathologic process already compensated by other methods of respiration.

Pain in the Supraspinatus Muscle

The normal and pathologic mechanics of the muscle have been very fully described by Codman. There would appear to be two clinical problems, however, of very frequent occurrence: (1) pain in the supraspinatus tendon not accompanied with pain in the muscle, and (2) pain in the supraspinatus tendon accompanied with pain in the muscle.

The first of these conditions is that found in Codman's bursitis, in which the tendon of the supraspinatus muscle is involved in inflammatory conditions of the subacromial bursa. In these cases calcified material may even be deposited in the tendon without causing pain at any other part of the supraspinatus except its tendinous insertion. In such cases one finds the classic referral of pain to the insertion of the deltoid.

In the second group of cases, in which there appears to be pain at both origin and insertion of the supraspinatus muscles, one seems to be dealing with a different clinical entity and there is not the classic referral of pain to the insertion of the deltoid. Instead, in these cases there is sometimes a further mention of pain in the outer border of the elbow and forearm.

What is the pathologic basis in this second group of cases supraspinatus pain? The location of the pain in both origin and insertion of this mus-

cle seems to suggest a form of strain similar to that of tennis elbow. The condition often responds rapidly to heat therapy combined with injections of procaine into the regions of both muscular origin and tendinous insertion of the supraspinatus.

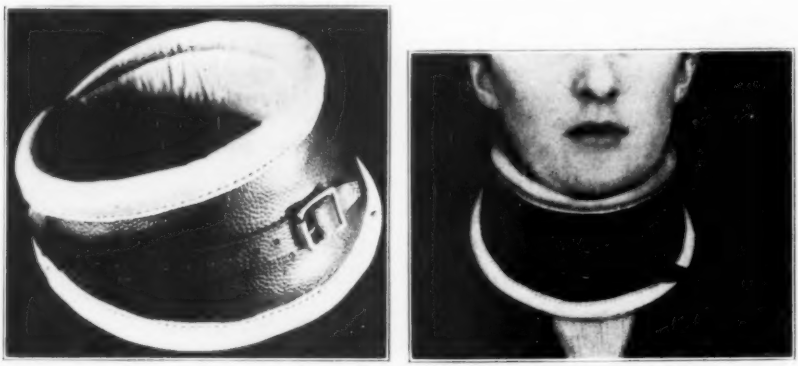
In using procaine for this form of therapy, one should avoid preparations containing epinephrine; such preparations are for the use of surgeons who find the vasoconstrictive effects of epinephrine necessary to limit bleeding. The physiatrist's purpose is not only to relieve pain and spasm but to induce revascularization of the tissues, and it is possible that neglect of this precaution may explain failures in this form of treatment.

The reference of pain in this group of cases to the outer border of the elbow and forearm may possibly be explained by the fact that this region is in the same dermatome (fifth and sixth cervical) as the supraspinatus muscle.

During the clinical investigation the patient often complains chiefly of pain in the outer border of the elbow and forearm, and I find that it is a wise precaution in all cases of suspected tennis elbow to examine the supraspinatus muscle and its tendon for evidence of deep pain.

Pain Associated with Faults in the Lower Cervical Portion of the Spine

Roentgenograms of patients complaining of pain associated with faults in the lower cervical portion of the spine may show any of the following conditions: narrowing of disk spaces; osteophytic outgrowths from the articular edges of vertebrae, sometimes involving the intervertebral foramens; fusion of vertebra, and spina bifida occulta.



Collar for Use With Prolapsed Cervical Disk.

This group of abnormalities is so similar to that found in the rotengenographic appearances of the lumbar portion of the spine in many painful conditions of the back and lower limbs that they seem to suggest a common origin, probably a congenital origin based on the failure of the tissues which form the vertebral laminae to complete their embryologic function of separating the notochord from its original connection with the ectoderm. The cervical and the lumbar portion of the spine are the last two places to complete this natural closure. It may therefore be debatable whether prolapse of a disk is partly the result of this congenital fault or not. There appears to be a tendency now to look upon prolapse of a cervical intervertebral disk as a condition for which surgical treatment is unlikely to be necessary.

Russell Brain[3] has pointed out that a useful point in differential diagnosis is that in prolapsed cervical disk flexion of the cervical part of the spine increases the pain, whereas in osteoarthritis of this part of the spine, extension increases the pain.

For brachial neuralgia associated with prolapsed cervical intervertebral disk traction of the cervical spine by means of Sayers suspension gear with the patient sitting in a chair is effective in some cases. Supension for about two minutes, increasing to five minutes, is given daily and followed by gentle exercises of cervical spinal muscles.

In case of a prolapsed disk, a firm leather collar lined with soft leather can be worn after these exercises to prevent flexion of cervical spine, allowing the busy housewife to carry on with her household duties without fear of accidentally applying flexion strain to the cervical portion of the spine.

3. Brain, W. Russell: Lancet **1**:393, 1948.

Discussion

Dr. Ben L. Boynton (Dallas, Texas): I have been particularly impressed with Dr. Shulman's very practical, simple, direct and brief presentation of a subject which could go on for many hours, and I have been impressed, among other things, with the following fact: We have a tendency to lump osteoarthritis of the spine and not focus attention, as Dr. Shulman has so ably done, on the costotransverse articulation, for example. I think he has really done us a service to call our attention to this particular area, which may be the focus of pain.

I was, again, very much interested in the supraspinatus syndrome which Dr. Shulman mentioned briefly and, particularly, his comments regarding the use of procaine infiltration and the use of epinephrine. I have seen several patients who have had infiltration with procaine — and I have always used epinephrine — who have not had a successful result. I think that at the next opportunity which arises, I shall omit the epinephrine, and I shall look forward to better results.

As to faults in the lower cervical spine, unfortunately, Dr. Shulman did not have any way of projecting some of the roentgenograms which he brought with him. I did, however, have the opportunity to view them, and the thing which, again, impressed me about Dr. Shulman's approach was that whenever I have seen a patient whom I felt had a herniated disk, let us say, of the cervical portion of the spine, I thought the only possible treatment other than to wear a most cumbersome collar, was surgical. Dr. Shulman's ingenuity in designing a simple, practical and easily removed and easily put-on leather collar, I think, has made a real contribution.

PHYSICAL MEDICINE AT THE AMERICAN MEDICAL ASSOCIATION

Physical medicine will be represented extensively once again during the annual sessions of the American Medical Association at Atlantic City from June 6 to June 10. Once more there will be a Special Exhibit on Physical Medicine and Rehabilitation among the scientific exhibits and this year the Special Exhibit will be sponsored by the Baruch Committee on Physical Medicine. This year there will be two Sessions on Physical Medicine instead of one and according to present plans, these sessions will be held in the Ocean Room at the Marlborough-Blenheim Hotel on Wednesday morning, June 8 and Thursday morning, June 9. It is important that those of us who are interested in physical medicine give full support to these sessions and members of the Congress are urged to make their hotel reservations early and to mark the time and location on their calendars and make plans to attend this important meeting.

AN EVALUATION OF THE QUESTION OF ANOXIA IN FEVER THERAPY *

EDWARD E. GORDON, M.D.
Baruch Fellow in Physical Medicine
ROBERT C. DARLING, M.D.
and
ETHEL SHEA, A.B.
NEW YORK

During the application of physical hyperthermia, patients often manifest a striking cyanosis in addition to cerebral disturbances, such as restlessness, excitement, confusion and disorientation. Whether these signs reflect local disturbances or bespeak a generalized anoxia —i. e., anoxic anoxia — is important to know; for, if the latter state prevails, oxygen administration should be a primary consideration in the management of patients submitted to this procedure.

Merely on clinical grounds numerous observers[1] emphasized the presence of a generalized anoxia and recommended continuous oxygen administration during physical fever. On the other hand, one of the few dissenting reports may be quoted:[1b] ". . . the clinical picture described was not that of simple anoxia, but one in which anoxia seemed to be a complication of the condition. With true anoxia such as seen so often in experimental work in aviation, cerebral involvement would have been a much more marked and lasting picture."

Experimental data have been presented to support the contention of the presence of anoxic anoxia, yet critical analysis finds them inconclusive. Such experiments dealing with oxygen content of venous blood in animals[3] and human beings[4] must be discarded because of the well known arterialization of venous blood in an extremity in hot environments due to increase in circulation. Other experiments in animals indicating an important decline in arterial oxygen saturation in artificial fever do not correspond to actual clinical conditions, either because of the shallow tachypnea observed[5] or the drastic experimental conditions leading to shock and death.[6] From another avenue of approach, the similarity of histologic changes in the brain cells of persons dying during hyperthermia to those observed after death by an-

* From the Department of Medicine, Columbia University, College of Physicians and Surgeons, and the Presbyterian Hospital in the City of New York.
* This work was aided by a grant to Columbia University from the Baruch Committee on Physical Medicine.
* Read at the Twenty-Sixth Annual Session of the American Congress of Physical Medicine, Washington, D. C., Sept. 9, 1948.

1. (*a*) Wallace, J., and Bushby, S. P. M.: Hazards of Hyperthermia Treatment, Lancet **2**:459 (Oct. 7) 1944. (*b*) King, A. J.; Williams, D. L., and Nicol, C. S.: Hyperthermia in the Treatment of Resistant Gonococcal and Non-Specific Urethritis, Brit. J. Ven. Dis. **19**:141 (Dec.) 1943. (*c*) Craig, D. M.; Schwemlein, G. X., and Kendell, H. W.: Artificial Fever — Chemotherapy: II. Arterial Oxygen Saturation, Arch. Phys. Med. **25**:665 (Nov.) 1944. (*d*) Etter, H. S.: Some Complications of Therapeutic Hyperpyrexia, ibid. **25**:154 (March) 1944.

3. Knudson, A., and Schaible, P. J.: Physiologic and Biochemical Changes Resulting from Exposure to an Ultrahigh Frequency Field, Arch. Path. **11**:728 (May) 1931. Nasset, E. S.: Physiological Effects of High Frequency Current: III. The Carbon Dioxide and Oxygen Content and Capacity and the Concentration of Blood of Anesthetized Dogs, Am. J. Physiol. **101**:203 (June) 1932.

4. Bischoff, F.; Long, M. L., and Hill, E. J.: Studies in Hyperthermia; II. The Acid Base Equilibrium in Hyperthermia Induced by Short Radio Waves, J. Biol. Chem. **90**:321 (Jan.) 1931. Bierman, W., and Fishberg, E. H.: Some Physiologic Changes During Hyperpyrexia Induced by Physical Means, J. A. M. A. **103**:1354 (Nov. 3) 1934.

5. Uyeno, K.: Studies on the Respiration and Circulation of the Cat: III. The Effect of Rise of Body Temperature, J. Physiol. **57**:203 (March 21) 1923

6. Hartman, F. W., and Major, R. C.: Pathological Changes Resulting from Accurately Controlled Artificial Fever, Am. J. Clin. Path. **5**:392 (Sept.) 1935.

oxia has been claimed to indicate the presence of anoxia;[7] however, shift in water and electrolytes from the intracellular to the extracellular spaces has been reported to produce similar changes.[8] Moreover, the role of thermal damage itself remains unexplored.

Evaluation of arterial blood in human subjects during artificial fever has consisted mainly in the measurement of oxygen saturations and yielded results which, by themselves, do not explain the clinical findings of cyanosis and cerebral impairment. Thus, by means of the oximeter, an average reduction of about 5 per cent was noted,[1c] and direct analysis with the Van Slyke apparatus yielded similar results.[9] The authors came to opposite conclusions regarding the necessity for oxygen therapy during fever.

To settle conclusively the question whether a state of generalized anoxia exists, data on oxygen saturation alone are inadequate; oxygen tensions are far more important in ascertaining whether an adequate oxygen supply is available to the tissues. Only one study in this regard, by Cullen, Weir and Cook,[10] has appeared in the recent literature. They found an arterial oxygen tension of about two-thirds of normal, although oxygen saturation remained at the comparatively high figure of 90 per cent. In line with their finding of anoxic anoxia, oxygen administration raised the arterial tension. Such therapy also reduced the degree of tachycardia characteristically found in physical hyperthermia when this agent is not supplied. This work has been widely quoted as support for the contention that generalized anoxia is a concomitant of physical hyperthermia. However, their data on oxygen tensions appear to have several weaknesses. The effect of elevated temperature upon their calculations was not taken into account. Secondly, the influence of acid-base equilibrium, which is known to change radically during hyperthermia, was not accurately reckoned with. Finally, interpolation of oxygen tension from a "standard curve," as mentioned in the report, is an inaccurate procedure.

Thus, according to previous work, the presence of anoxic anoxia in physical hyperthermia is not clearly established and, consequently, it cannot be positively specified as the underlying mechanism for the apparent tissue anoxia. As a preliminary approach to the question of anoxic anoxia, we are reporting a survey of the effect of oxygen therapy on the pulse rate in patients subjected to physical hyperthermia, realizing that pulse rate may not be a sensitive enough index of the degree of anoxia we are trying to detect. As a more nearly direct approach, we are reporting measurements of arterial oxygen tensions and saturations. In order to make our conclusions as definitive as possible we have (1) studied human subjects under actual clinical conditions; (2) used the best available technics; (3) avoided assumptions in calculations, which have weakened previous work; (4) controlled our subjects as far as possible, especially in respect to the use of sedatives, which variable has not received proper emphasis in the literature. From this study it should be possible to say whether the clinical disturbances in hyperthermia are, in fact, due to anoxic anoxia and, therefore, whether oxygen administration is logically indicated as a routine procedure in fever therapy.

Method

Physical fever was induced in the Emerson hot humid air cabinet, the time to attain a body temperature of 104 F. being 80 to 120 minutes. An additional three to

7. Hartman, F. W.: Lesions of the Brain Following Fever Therapy, J. A. M. A. **109**:2116 (Dec. 25) 1937.

8. Yannet, H., and Darrow, D. C.: The Effect of Hyperthermia on the Distribution of Water and Electrolytes in Brain, Muscle and Liver, J. Clin. Investigation **17**:87 (Jan.) 1938.

9. Looney, J. M., and Bercovic, E. J.: The Changes Produced on the Oxygen and Carbon Dioxide Content of Arterial and Venous Blood of the Brain During Diathermy Therapy for General Paresis, Am. J. Physiol. **136**:177 (March) 1942.

10. Cullen, S. C.; Weir, E. F., and Cook, E.: The Rationale of Oxygen Therapy During Fever Therapy, Anesthesiology **3**:123 (March) 1942.

four hours at 104 to 106 F. was maintained. Adequate fluid intake (at least 5 cc. per kilogram per hour) was provided.

Pulse Rate Studies. — Ten subjects with syphilis of the central nervous system but free of cardiac or respiratory diseases and cardiac arrhythmia were subjected each to twelve sessions of fever ranging from 104 to 106 F. for three to four hours. For each patient the following procedure was adopted: Sedation was given, the amount and character being kept nearly the same in all twelve sessions. In each subject during alternate treatments oxygen was administered from the induction to the end of fever by means of a nasopharyngeal catheter. Pulse rate at the radial artery was recorded every ten minutes during the plateau of fever, and the measurements were arranged into two groups, each representing six sessions with and without oxygen, respectively; the total pulse rates thus combined equaled 100, more or less, per group. Within each group, pulse rates were further segregated into classes with intervals of 10 beats per minute, in order to find the frequency distribution in each class. By this means comparative histograms with and without oxygen could be constructed to facilitate statistical analysis of the effect of oxygen administration upon pulse rate. For the purposes of the study, frequencies were expressed in per cent of total pulse rates counted in each group, since numbers of measurements were not necessarily identical in two corresponding groups.

Arterial Gas Tensions. — In another set of 8 patients, experiments on blood gases were made in order to determine directly the presence of generalized anoxia. This included 2 healthy subjects and 5 patients with neurosyphilis and 1 with a nonspecific iritis, in all of whom no cardiovascular or pulmonary diseases could be detected by the usual clinical tests. In all, fifteen experiments were performed at elevated body temperatures. Of the 8 subjects, 6 also served as controls at normal body temperature.

Thirty to ninety minutes after a temperature of 104 F. was reached, a sample of arterial blood was withdrawn. Usually the temperature at this time was 105 F., but in a small number it varied from 104.2 to 106.1 F. For control studies, blood was withdrawn at the bedside on a different day from that on which experiments with fever were carried out. Although it was realized that for ideal controls determinations should have been made on the same day before the induction of fever, limitations in time dictated our procedure. However, since blood gas tensions depend mainly on pulmonary function, under our conditions measurements could be expected to show no significant day to day variations.

While subjected to physical hyperthermia patients are usually given sedation to allay the restlessness and discomfort entailed in this procedure. It was noted that this medication affected some of the results. For this reason six experiments on as many subjects were done with insignificant or no sedation, in order to investigate the effect of fever without this variable. Results were, therefore, divided into sedated and nonsedated groups. Sedation consisted of one dose of sodium Luminal, 0.09 gm. plus either one or two doses of morphine sulfate, 10 mg., or Dilaudid, 1.0 to 1.5 mg., or Demerol, 50 mg. Medication was administered from a quarter-hour to three hours preceding blood sampling.

The technic for determining arterial oxygen tension at normal body temperature has been described by Dill and co-workers[11] and need not be given here. Certain modifications in calculation, necessary because of elevated temperature, were made as described elsewhere.[12] Suffice it to say that five samples of blood were equilibrated in sealed Barcroft tonometers at oxygen tensions of 60, 70, 80, 90 and 220 mm. of mercury, respectively, and all at a carbon dioxide tension of 40 mm. of mercury at the rectal temperature prevailing when the blood was withdrawn. Actual gas tensions were then found with the Haldane gas analyzer, and the carbon dioxide and oxygen contents of the blood were determined by means of the Van Slyke manometric apparatus. Another sample of blood was analyzed directly upon withdrawal for carbon dioxide and oxygen contents. Proper precautions were taken against glycolysis and exposure to air. By means of the data thus derived it was possible to establish partial carbon dioxide and oxygen dissociation curves for each blood, place the observed arterial point on each curve, read off the corresponding gas pressures and calculate the pH values.

In order to check further the values for arterial carbon dioxide and oxygen tensions, a second and entirely independent method was used, that of the aerotonometer as described by Riley and co-workers.[13]

11. Dill, D. B.; Graybiel, A.; Hurtado, A., and Taqumi, A. C.: Der Gasaustausch in den Lungen im Alter, Ztschr. f. Altersforsch. **2**:20, 1940.

12. Gordon, E. E.; Darling, R. C., and Shea, E.: Effects of Physical Hyperthermia upon Blood Gas Equilibria in Man, J. Applied Physiol., to be published.

13. Riley, R. L.; Proemmel, D. D., and Franke, R. E.: A Direct Method for Determination of Oxygen and Carbon Dioxide Tensions in Blood, J. Biol. Chem. **161**:621 (Dec.) 1945.

Results

Pulse Rate. — With the purpose of ascertaining whether oxygen inhalation influenced pulse rate, in each of the 10 patients histograms depicting the frequency distribution of pulse rate with and without oxygen administration between 104 and 106 F. were constructed (chart 1). Since the time-temperature range was not exactly the same in all six sessions of fever upon which each histogram was based, the average weighted temperature for all six sessions was calculated for purposes of comparison. In corresponding histograms the average temperature does not vary by more than 0.5 degree fahrenheit, while the average time of observation was three hours for all.

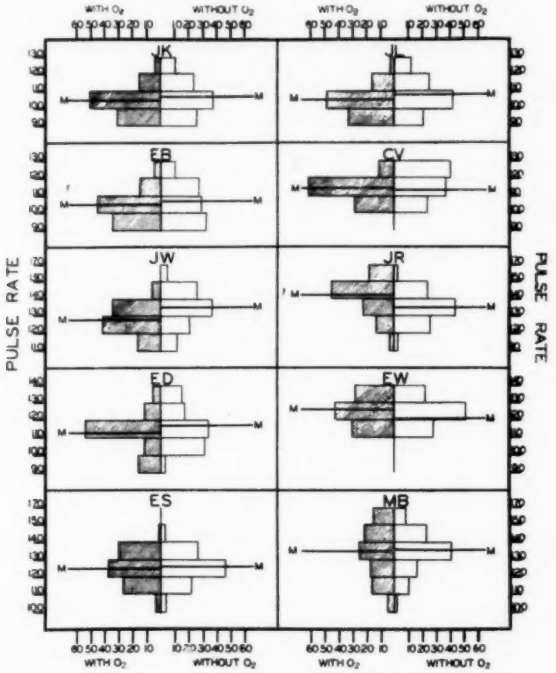


Chart 1. — Effect of administration of oxygen on pulse rate as represented by the mean (M) and the frequency and distribution of pulse rate based on measurements in six sessions with the six sessions without oxygen in 10 patients. In each case the abscissa represents frequency in per cent of total count, and the ordinate represents class interval of 10 beats per minute.

In comparing the experimental with the control data, no consistent effect of oxygen administration upon pulse rate was apparent. Thus, the configurations of corresponding histograms in all patients showed no consistent trend that could be interpreted as an amelioration of anoxia by oxygen therapy — i. e., a shift of the peak downward (chart 1). This failure to respond is reflected in mean pulse rate: Three patients (J. W., E. D., J. L.) exhibited a fall of 3 to 7 beats per minute; 2 (E. W., J. R.) showed a rise of 5 and 7 beats, respectively, and the remaining 5 showed no change. Unfortunately, it was not possible to attain the same average body temperature in some patients during control and experimental periods, and the degree of sedation in the same subject during the various sessions must remain speculative.

For these reasons, in addition to the fact that diminution in pulse rate with oxygen administration offers only presumptive evidence for the existence of anoxia, it was not thought profitable to present a more detailed analysis of the data. However, it is safe to say that while small changes in pulse rate, if present, could not have been detected, certainly, contrary to the report of Cullen, Weir and Cook,[10] oxygen administration does not produce a reduction of 10 to 20 beats per minute. However, such experiments yield only indirect evidence, and the more crucial tests on blood oxygen determinations are to follow.

Arterial Blood. — Before turning to a consideration of direct evidence for or against the presence of arterial anoxia, related findings pertaining to the acid-base equilibrium in the blood during fever may be presented. When no sedation was administered, an uncompensated hyperventilation alkalosis supervened, indicated by the fall in arterial carbon dioxide tension and rise in *p*H (table 1). This condition is well known and if severe enough leads to tetany.[14] Large changes in an alkaline direction of the order of 0.2 *p*H as previously reported[15] were not confirmed even when carbon dioxide tension fell below 30 mm. Hg. (subject L. R. in table 1). Not heretofore realized, however, is the effect of sedation in preventing the appearance of hyperventilation alkalosis. In all but 1 patient (M. K.) normal values of carbon dioxide tension and *p*H or values consistent with a CO_2 retention acido-

TABLE 1. — *Effect of Physically Induced Fever (40.1-41.2 C.) on the Carbon Dioxide of the Arterial Blood.**

Subject	pCO_2 Tonometer (Mm. Hg.) 37 C.	Fever	Difference	pCO_2 Aerotonometer (Mm. Hg.) 37 C.	Fever	Difference	*p*H Values 37 C.	Fever	Difference
M. K.	43	38	—5	44	....	....	7.38	7.42	+.04
R. C.	41	29	—12	42	33	—9	7.42	7.44	+.02
E. G.	41	33	—8	34	32	—2	7.41	7.47	+.06
R. D.	44	30	—14	41	29	—12	7.38	7.51	+.13
L. R.	39	28	—11	38	27	—11	7.41	7.54	+.13
G. Q.	39	33	—6	39	44	+5	7.43	7.49	+.06
Average	41	32	—9	39†	33	—6	7.41	7.48	+.07

* Blood during fever taken after little or no sedation of the patient.
† Average of five.

sis were observed (table 2). It is thus apparent that sedative drugs, which must often have been used during hyperthermia, play an important part in determining *p*H of the blood, and it is possible that failure to take this into account explains some of the low *p*H values reported in the literature.[16]

In contrast to the effect upon blood carbon dioxide, arterial oxygen tensions remained unaltered during physical hyperthermia whether sedation was administered or not. Thus, in table 3 it is shown that in the unsedated group there is no significant variation of oxygen tension between control and fever bloods as determined by either the tonometer or the aerotonometer technics. The former method gives somewhat lower values than the latter; the reasons for this discrepancy have been pointed out by Roughton and co-workers.[17] It

14. Koehler, A. E. Acid-Base Equilibrium: I. Clinical Studies in Alkalosis, Arch. Int. Med. **31**: 590 (Jan.) 1923.
15. Cajori, F. A.; Crouter, C. Y., and Pemberton, R.: The Effects of Therapeutic Application of External Heat on the Acid-Base Equilibrium of the Body, J. Biol. Chem. **57**:217 (Aug.) 1923. Landis, E. M.; Long, W. L. Dunn, J. W.; Jackson, C. L., and Myer, U.: Studies on the Effects of Baths on Man: III. Effects of Hot Baths on Respiration, Blood and Urine, Am. J. Physiol. **76**:35 (March 1) 1926. Bischoff, Long and Hill.4 Kohler.14
16. Fishberg, E. H., and Bierman, W.: Acid-Base Balance in Sweat, J. Biol. Chem. **97**:433 (Aug.) 1932. Ferguson, C., and Buckholtz, M.: Effect of Hyperpyexia on pH Figure of Blood, Arch. Phys. Therapy **22**:333 (June) 1941.
17. Roughton, F. J. W.; Darling, R. C., and Root, W. S.: Factors Affecting the Determination of Oxygen Capacity, Content and Pressure in Human Arterial Blood, Am. J. Physiol. **142**:708 (Dec.) 1944.

is emphasized that not absolute but comparative values are required, and this has been attained in the same subject with two independent technics by determining arterial oxygen tensions at normal and at elevated body tem-

TABLE 2. — *Arterial Blood During Fever in Sedated Patients.*

Subject	O_2 Sat. (%)	Tonometer pO_2 (Mm. Hg.)	Tonometer pCO_2 (Mm. Hg.)	Aerotonometer pO_2 (Mm. Hg.)	Aerotonometer pCO_2 (Mm. Hg.)	pH Values
M. K.	90.2	66	32	.....	....	7.48
J. G.	93.9	81	43	.....	....	7.38
J. G.	92.0	65	44	103	30	7.36
J. G.	94.0	80	44	86	44	7.34
C. K.	93.6	74	40	.....	....	7.40
C. K.	96.9	95?	43	100	40	7.37
C. K.	87.0	63	50	79	53	7.34
R. C.	94.6	88	41	98	48	7.39
L. R.	90.9	71	42	96	53	7.37
Average	92.6	76	42	94	45	7.38
Unsedated patients, average	93.6	75	32	95	33	7.48

TABLE 3. — *Effect of Physically Induced Fever (40.1-41.2 C.) on the Oxygen in the Arterial Blood.**

Subject	O_2 Saturation (%) 37 C.	Fever	Difference	pO_2 Tonometer (Mm. Hg.) 37 C.	Fever	Difference	pO_2 Aerotonometer (Mm. Hg.) 37 C.	Fever	Difference
M. K.	94.8	92.9	—1.9	66	70	+4	98	.....	..
R. C.	96.7	95.6	—1.1	83	82	—1	104	103	—1
E. G.	93.3	93.8	+0.5	83	74	—9	94	87	—7
R. D.	96.5	94.3	—2.1	78	81	+3	94	88	—6
L. R.	93.0	91.0	—2.0	66	69	+3	104	104	0
G. Q.	93.0	94.1	+1.1	67	73	+6	94	94	0
Average	94.5	93.6	—0.9	74	75	+1	98†	95	—3

* Blood during fever taken after little or no sedation of the patient.
† Average of five.

peratures. Arterial oxygen tension also remained unaltered during fever in the sedated patients as judged by the average values derived from both groups (table 2). Only in 1 instance (C. K.) was there any indication of anoxic levels (pO_2 = 63 mm. Hg. and 79 mm. Hg. by tonometer and aerotonometer methods, respectively); here undue sedation may be responsible, for a carbon dioxide tension of 50 mm. of mercury was strongly suggestive of some degree of respiratory depression. However, even including this exception, we are unable to confirm the findings of Cullen and co-workers of a 30 per cent reduction in arterial oxygen tension; nor do we have evidence of any degree of arterial hypoxia during fever.

Oxygen saturations were quite consistent with observations on arterial oxygen tension. Thus in the experiments at 37 C. and in sedated and unsedated fever there was a deviation of no more than 2 per cent in average oxygen saturations among the three groups, with a great deal of overlapping in individual values (tables 2 and 3). Reduction in saturation by 5 to 10 per cent or more of normal during fever[18] was not encountered except in the 1 instance already mentioned (C. K.) in which respiratory depression by drugs was probably operative. However, emphasis upon oxygen saturation is not justified, since arterial oxygen tension is more important in assessing the presence of tissue anoxia. Thus, a statement as to the level of saturation unaccompanied by corresponding oxygen (tension) values may be misleading,

18. Craig, Schwemlein and Kendell.1c. Hartman and Major.6 Looney and Bercovic.9

since (1) at elevated temperatures oxygen tensions may actually be higher for any given oxygen saturation, owing to the shift of the oxygen dissociation curve to the right with elevated temperature,[12] and (2), as is well known, pH also influences the position of the curve.

This dual effect of temperature and pH upon the relationship of oxygen saturation and tension is demonstrated by chart 2. Oxygen dissociation curves as determined experimentally under the several conditions of temperature alone or with sedation have been plotted for 6 persons. Each curve was adjusted to the pH of the arterial blood. The expected relationship between curves at the two temperatures in question and the characteristic effect of pH are brought out. Thus, it is noted that the curve at elevated temperature is to the right of that corresponding to normal body temperature.

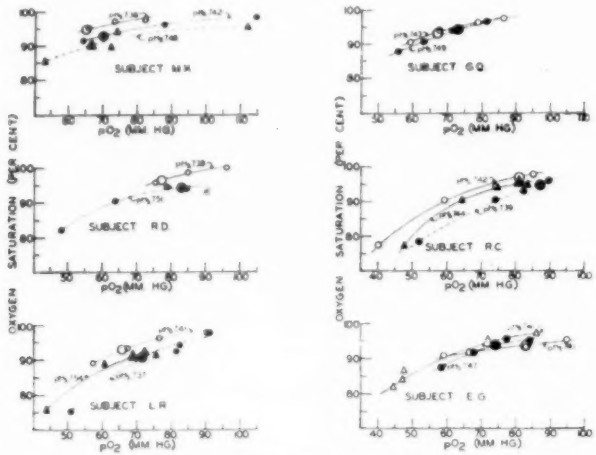


Chart 2. — Graphs of partial oxygen dissociation curves on 6 subjects under various conditions of temperature and sedation, showing positions of arterial points. Explanation of symbols: open symbols, 37 C.; solid symbols, fever 40 to 41 C.; small symbols, experimental (tonometer) points; large symbols, arterial points; dotted curves, moderate sedation; unbroken curves, minimal or no sedation; all at arterial pH.

Second, the opposite tendencies of alkalinity and temperature may place the curve close to the control (G.Q., E.G.). Third, an acid pH in combination with elevated temperature is most effective in displacing the curve to the right as compared to the control (L. R., R. C.). Only M. K. presents, for unexplained reasons, a deviation from the last rule. The data also illustrate the fact that a lower saturation does not necessarily imply anoxia, since in no instance is there an accompanying fall in oxygen tension. In fact, in none of the conditions prevailing, does arterial oxygen tension during fever fall below the corresponding control value.

Comment

The major physiologic disturbance in respect to blood gas equilibriums is an uncompensated alkalosis due to the hyperventilation attendant on elevated temperature. Such a finding is in harmony with the extensive literature on this subject, but it should be emphasized that only in unsedated patients have we found this condition to prevail. The alkalosis may be attributed to thermal stimulation of the respiratory center leading to hyper-

ventilation and, consequently, a decreased arterial carbon dioxide tension. Such a physiologic mechanism can be postulated upon the work of Heymans and Ladon,[19] who observed in cross perfusion experiments in dogs a response of the respiratory center to small changes in temperature of the perfusate. Equally as important in augmenting respiration may be the anxiety and discomfort associated with the procedure of inducing physical fever itself. Thus, for example, an emotionally unstable subject (M. K.) exhibited a low blood carbon dioxide tension in spite of sedation (table 2). On the other hand, if thermal and emotional stimuli are counteracted by adequate sedation, a moderate acidosis may supervene due to carbon dioxide retention, or pH may remain within normal limits.

The contention that arterial anoxia is a concomitant of physical hyperthermia has not been corroborated by indirect evaluation of the effect of oxygen administration upon pulse rates or by the direct assessment of arterial oxygen tensions. Arterial anoxia is only an occasional occurrence, following oversedation or, conceivably, pulmonary edema, and, consequently, little would be gained with routine oxygen administration. Since the blood coming from the lungs is practically entirely saturated, any increase in oxygen content must depend almost entirely on physically dissolved oxygen. Thus, inhalation of 100 per cent concentrations of this gas would yield an alveolar oxygen tension, assuming a carbon dioxide tension of 30 mm. of mercury, of 673 mm. of mercury, or a rise in physically dissolved oxygen of less than 1.7 cc. per hundred cubic centimeters of blood.

The common clinical observations of cyanosis and cerebral impairment remain to be explained on some basis other than arterial anoxia. It would seem more likely that these signs are manifestations of local disturbances — e. g., peripheral vasoconstriction giving rise to tissue anoxia. Stewart has demonstrated a slowing of blood flow in the hands with forced breathing;[20] Gibbs and co-workers have noted similar changes in cerebral circulation concomitant with a rise in arteriovenous oxygen difference.[21] More specifically, Himwich and his co-workers observed a subject during physical hyperthermia who lapsed into coma when the brain arteriovenous oxygen difference rose to 15.8 volumes per cent.[22] The majority of their subjects also showed significant changes in arteriovenous differences but without clinical manifestations. Thus, it may be postulated that the hyperventilation alone may produce an ischemic anoxia. If the effect of reduced volume of blood flow is further reinforced by a rise of metabolism, which is known to occur, cyanosis and cerebral disturbances may well ensue without the presence of an arterial anoxia. Under conditions of ischemic anoxia with a normal arterial blood, theoretically, oxygen administration might be expected to cause some benefit by virtue of the small amount of added dissolved oxygen in the blood thus available to the ischemic tissue. However, since a nasopharyngeal catheter is the most efficient, practical device for giving oxygen during hyperthermia and the concentration thus achieved is only 40 per cent (or 0.7 volumes per cent added oxygen), the effect will be small and probably insufficient to justify the routine use of oxygen.

It would appear that rather than routine use of oxygen therapy, a simpler approach rests in the prevention of ischemic anoxia and its sequelae by

19. Heymans, C., and Ladon, A.: La tête du chien isolée et hyperthermisée, Compt. Rend. Soc. de Biol. **92**:455 (Jan. 31) 1925.
20. Quoted in Best, C. H., and Taylor, N. B.: Physiological Basis of Medical Practice, Baltimore, William Wood & Company, 1939, p. 411.
21. Gibbs, F. A.; Maxwell, H. P., and Gibbs, E. L.: Volume Flow of Blood Through the Brain of Man at Rest, During Hyperventilation and While Breathing High CO_2, Fed. Proc. **5**:33 (March) 1946.
22. Himwich, H. E.; Bowman, K. M.; Goldfarb, W., and Fazekas, J. F.: Cerebral Metabolism During Fever, Science **90**:398 (Oct. 27) 1939.

controlling hyperventilation alkalosis. For this purpose, the cautious use of sedatives is highly desirable, for, as we have shown, hyperventilation does not appear in effectively sedated patients.

Summary and Conclusions

1. The question of generalized anoxia in patients undergoing physical hyperthermia at 104 to 106 F. was explored by two methods of attack: (1) Pulse rate was measured every ten minutes in 10 patients undergoing fever therapy, each during six sessions without oxygen therapy and again during six alternate sessions while receiving oxygen continuously by nasopharyngeal catheter; (2) in another set of 8 subjects, arterial blood gases were extensively studied at normal and elevated temperatures with and without sedation. By the classic tonometer technic the pressures of carbon dioxide and oxygen were determined, the latter by constructing an individual oxygen dissociation curve of each blood at the temperature of the patient. The *p*H was readily and accurately calculated from the data so obtained. As a further check on blood gas determinations, arterial oxygen and carbon dioxide tensions were found more directly by a second and independent technic, that by an aerotonometer.

2. *Pulse Rate Changes.* — Analysis of the histograms of the frequency distribution of the pulse rate with and without oxygen revealed no regular slowing of pulse rate when oxygen was given. Three patients showed a drop of 3 to 7 beats per minute in mean pulse rate; 2 showed a rise of 5 and 7 beats, respectively. None of these changes are of undoubted statistical significance. Thus, within the limits of this analysis and within the limitations of the use of pulse rate as an index, there was no evidence of anoxia.

3. *Arterial Blood Gas Changes.* — In patients not receiving sedation an uncompensated hyperventilation alkalosis ensued, as reflected in elevated *p*H and decreased carbon dioxide tension. In adequately sedated patients, *p*H was found to be slightly reduced or normal with corresponding changes in arterial carbon dioxide tension.

Arterial oxygen tension during fever ranging from 104 to 106 F. with or without sedation was unchanged from that found at normal body temperature. This finding was derived from data from two independent methods. Oxygen saturations also remained unaltered. Thus our experiments failed to confirm the idea of an anoxic anoxia during hyperthermia. The clinical observations of cyanosis and mental confusion during hyperthermia require another explanation, possibly ischaemic anoxia due to slowed local circulation.

4. The necessity of complete blood gas studies and the incompleteness of measurements of oxygen saturation alone are emphasized and discussed. The balancing effect of the two main factors influencing the affinity of hemoglobin for oxygen has been reevaluated; increase in temperature reducing the affinity, rise in *p*H increasing the affinity.

5. In the light of our experiments, routine administration of oxygen during physical hyperthermia would appear to be of only limited theoretical benefit. Sedation, which is of value in controlling the hyperventilation alkalosis, should consequently help to combat ischemic anoxia.

We gratefully acknowledge the cooperation of the Neurological Service in allowing us to study patients under their care.

We are grateful to the several nurses administering fever therapy at the Columbia Presbyterian Medical Center for their patient cooperation and wholehearted assistance.

Discussion

Dr. Ray Piaskoski (Milwaukee): This report by Dr. Gordon and his associates is an example of the superior grade of research work in physical medicine made possible in recent years by the encouragement and financial support of the Baruch Committee on Physical Medicine. It is this type of work which contributed so much to the final recognition of physical medicine as a separate and distinct specialty. I do not feel qualified to discuss this very interesting paper from the standpoint of physiology or laboratory technic employed, but I should like to say a few words from the practical clinical point of view.

Fever therapy is a time-consuming procedure, requiring specially trained personnel, special equipment and technics, and therefore is necessarily expensive. The continuous administration of oxygen during fever therapy adds considerably to the cost of treatment. Personal observation and experience in several thousand fever treatments during the last fourteen years corroborate Dr. Gordon's final conclusion that routine administration of oxygen during physical hyperthermia would appear to be unwarranted and that its use should be dictated by special conditions in individual cases.

I have always felt that the need for oxygen during fever therapy is directly proportionate to the severity of treatment. The severity of treatment in any patient is determined by many factors, among which may be mentioned the height of fever, the length of treatment, the patient's tolerance to heat, the skill of the fever nurse, the type of apparatus used, the concomitant administration of sulfonamide drugs, penicillin, arsenicals and other drugs and the judicious use of sedatives which was emphasized by Dr. Gordon. Any or all of these factors may be accurately controlled in most cases to lessen the strain of treatment. If a temperature level of less than 106 F. is maintained for less than five hours and treatment is administered by skilled and competent personnel under ideal conditions, administration of oxygen is rarely necessary. It has been our policy to give oxygen only in the presence of specific indications — cyanosis, mental confusion or restlessness — and then only for a few minutes at a time. If the desired effect does not follow, the fever level should be reduced and, if necessary treatment discontinued. If a fever level of 106 F. or higher is maintained for five or more hours, I believe the continuous administration of oxygen is desirable in most cases. I should like to ask Dr. Gordon several questions: 1. Have any studies of this nature been done in fever sessions exceeding five hours of sustained fever? 2. Were any of these patients given penicillin, arsenicals or any other antisyphilitic therapy during or immediately prior to a fever session? 3. What was the environmental or cabinet temperature necessary to induce and maintain fever levels?

Dr. H. D. Bouman (Madison, Wis.): Would the speaker be a little more specific about the sedation he has given in those experiments?

Dr. Gordon (closing): The amount of sedation that we have used has been according to the plan used at our institution for the last ten years. We start with about 1/6 grain of morphine and repeat it possibly once more if fever is prolonged over four hours. This may be augmented by either phenobarbital, 90 mg., or 50 mg. of Demerol, or perhaps 1 mg. of Dilaudid.

27th Annual Session

SCIENTIFIC EXHIBITS

Requests for application for scientific exhibit space for the 27th Annual Session, to be held at the Netherland Plaza Hotel Cincinnati, Ohio, Sept. 6 to 10, 1949, should be sent into the Central Office without delay. All requests must be received before June 1, 1949. Address all inquiries to Dr. Walter J. Zeiter, American Congress of Physical Medicine, 30 North Michigan Avenue, Chicago 2, Illinois.

EFFECTS OF IMPLANTED METALS ON TISSUE HYPERTHERMIA PRODUCED BY MICROWAVES *

BARBARA L. FEUCHT, R.P.T., M.S.,
A. W. RICHARDSON, M.S.
and
H. M. HINES, Ph.D.
IOWA CITY

Diathermy of wavelengths between 3 and 300 meters has been applied by the physical therapist since shortly after the first World War. In the application of diathermy, the technician has been cautioned to remove from the patient all surface metals which might be within the field of radiations. It was believed that the metals might cause a concentration of the field, thus producing burns.[1] Little work was done until recently to confirm this danger. In 1947 Lion[2] reported the field-concentrating effect of tantalum when immersed in electrolytes and irradiated with frequencies of 10 to 55 megacycles. He also demonstrated that it is possible to coagulate solutions of egg albumin at the points of field concentration. Etter, Pudenz and Gersh[3] implanted metals such as are used in surgery in animals and then exposed them to radiations of wavelengths of 8 to 24 meters. They concluded from histologic studies that, in the intact animal, destruction from heating did not occur in the tissues contiguous to the implanted metals. However, Lion pointed out that the depths at which the metals were implanted in these experiments may have been too great to permit a temperature increase sufficient to cause burning.

The recent approval by the council on Physical Medicine of the American Medical Association[4] of a microwave machine generating radiations of a frequency of 2,450 megacycles (12.25 cm. wavelength) offers another field of diathermy to be investigated. Some reports have been published on the biologic effects of microwaves.[5] None of these has made any reference to the effect of irradiation on tissue containing implanted metals. The following studies were conducted to determine whether any difference exists between the heating pattern produced by irradiation with microwaves in tissues containing implanted metals and that in tissues with no implants.

Experimental Studies

In Vitro Studies. — Experiments were carried out on blocks of fresh beef liver to determine whether the presence of metal implants would alter the heating pattern resulting from irradiation with microwaves. The liver blocks were placed in boxes constructed from Plexiglas in order to provide uniformity in size and depth. The boxes were of the dimensions of 8 by 8 by 4 cm. and were made from material ¼ inch thick. Holes were drilled in a horizontal line every 0.5 cm. in a side of the container, 4 cm.

* From the Department of Physiology, State University of Iowa.

1. Krusen, F. H.: Physical Medicine, Philadelphia, W. B. Saunders Company, 1941, p. 427.
2. Lion, K. S.: The Effect of the Presence of Metals in Tissue Subjected to Diathermy Treatment, Arch. Phys. Med. **28**:345 (June) 1947.
3. Etter, H. S.; Pudenz, R. H., and Gersh, I.: The Effects of Diathermy on Tissues to Implanted Surgical Metals, Arch. Phys. Med. **28**:333 (June) 1947.
4. Apparatus Accepted by Council on Physical Medicine, Chicago, American Medical Association, 1947.
5. Dailey, E. L.: A Clinical Study of the Results of Exposure of Laboratory Personnel to Radar and High Frequency Radio, U. S. Nav. M. Bull. **41**:1052 (July) 1943. Kemp, C. R.; Paul, W. D., and Hines, H. M.: Studies Concerning the Effect of Deep Tissue Heat on Blood Flow, Arch. Phys. Med. **29**:12-17 (Jan.) 1948. Leyden, W. M.; Herrick, J. F.; Wakim, K. G., and Krusen, F. H.: Preliminary Studies on the Heating and Circulatory Effects of Micro-Waves — "Radar," Brit. J. Phys. Med. **10**:177 (Nov.-Dec.) 1947. Osborne, Stafford, L., and Frederick, Jesse N.: Microwave Radiation; Heating of Human and Animal Tissues by Means of High Frequency Current with Wavelength of Twelve Centimeters, J. A. M. A. **137**:1936 (July 17) 1948.

from the top, to permit the insertion of thermocouple needles. Vertical slits were made at fixed distances from the front of the box so that a metal plate could be implanted after the liver had been arranged in place. Various-sized plates made from stainless steel were employed as metal implants.

All temperature measurements were made by insertion of an iron-constantan thermocouple needle of the type described by Tuttle and Janney.[6] The thermocouple potentials were measured to the nearest 0.1 degree centigrade on a Leeds-Northrup potentiometer.

The generator used in all the experiments produced a continuous microwave of 12.25 cm. wavelength, or 2,450 megacycles. Its maximum output was 125 watts. By the use of a variac, any desired percentage of the maximum output could be obtained. The wave guide used was the corner type reflector, which was placed at a distance of 3 cm. from the surface to be irradiated. The irradiation time for the in vitro experiments was ten minutes, and the power output was 80 per cent of the maximum, or 100 watts. Temperature measurements were made at the surface of the liver, at designated depths and in front and behind the metal implant immediately before and after ten minutes of irradiation. Control experiments were made on a block of the same liver subjected to the same pattern of irradiation but without metal implants.

The first series of experiments with liver was designed to determine whether the size of the implanted metal plate would affect the temperature increase resulting from the irradiation. It had been suggested that greater heating would result if the plates were equal in diameter to either one or one-half times the wavelength in the liver.

The wavelength in liver was determined as follows:

$$\text{Wavelength in liver} = \frac{\text{wavelength in air}}{\sqrt{\text{dielectric constant of liver}}} = \frac{12.25}{\sqrt{78}} = 1.39$$

Two round plates were then made from 26 gauge stainless steel. When corrected for capacitance, the diameters of these plates were 1.36 and 0.68 cm. A third stainless steel plate (6 by 6 cm.) was included in this series. The plates were implanted at a depth of 2 cm. from the surface to be irradiated. Temperatures were taken at the surface of the liver, at a depth of 1 cm. and in front of and behind the metal implant immediately before and after ten minutes of irradiation. A control group of experiments was performed at the same time by irradiating liver containing no implant. In this series the temperatures were taken in the same manner: namely, on the surface, at a depth of 1 cm. and at a depth of 2 cm.

A comparison of the temperature increases in the liver with and without metal implants can be seen in chart 1. When the round plates (1.36 and 0.68 cm. in diameter) were implanted, the average temperature increases were greater than those found in the controls. The increases at the surface and behind the plate were not significantly different from those in the controls. However, the increases at 1 and 2 cm. in front of the plate were significant. The levels of confidence were 0.1 and 1 per cent, respectively. None of the temperature increases found when the 6 by 6 cm. plate was implanted was significant when compared with controls. In general, the greatest degree of temperature increase was found at the surface, the increase being inversely related to depth.

Since no gross tissue damage was observed in the previous series of experiments in which the metal was implanted at a depth of 2 cm., the implantation depth was decreased to 0.5 centimeter. The Plexiglas containers and the three plates used in the previous series of experiments were also employed in this study. In addition a 2.5 by 2.5 cm. stainless steel plate was included. Control experiments (with liver in which no metals were implanted), also were carried out. The temperatures were taken at the surface, in front and behind the plate in the implant experiments. In the controls, temperatures were taken at the surface and at a depth of 0.5 cm.

Chart 2 is a comparison of the average temperature increases at the different depths in liver with the plates implanted at a depth of 0.5 cm. The average temperature increases at all depths with the 6 by 6 cm. plate implanted were significantly greater (0.1 per cent level of confidence) than the

6. Tuttle, W. W., and Janney, C. D.: The Construction, Calibration and Use of Thermocouples for Measuring Body Temperature, Arch. Phys. Med. 29:416 (July) 1948.

controls. The liver appeared to be coagulated between the surface and the front of the plate in an area roughly the size of the plate. There was also coagulation for a short distance behind the plate in the same area. When the 2.5 by 2.5 cm. plate was implanted, coagulation appeared between the surface of the liver and the front of the plate. However, coagulation was not always present behind the plate. The average temperature increases at

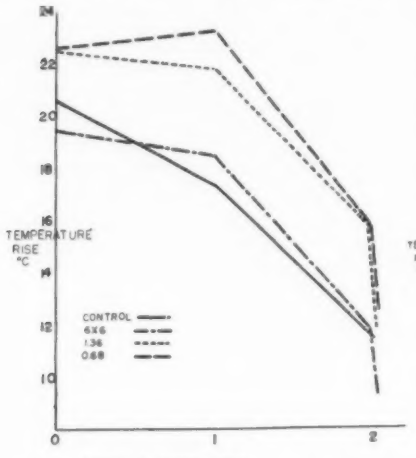


Chart 1. — Temperature increases in liver tissue in vitro following irradiation in Plexiglas boxes with 12.25 cm. microwaves. Stainless steel plates were implanted at a depth of 2 cm. Controls contained no metal plates.

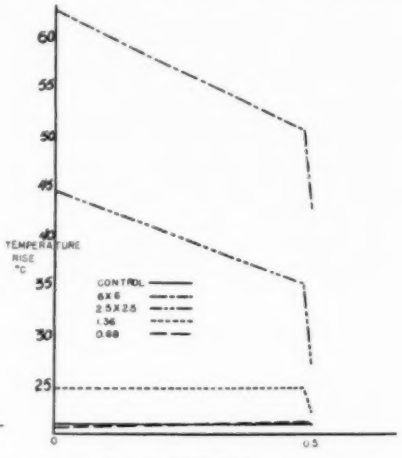


Chart 2. — Temperature increases in liver tissue in vitro following irradiation in Plexiglas boxes with 12.25 cm. microwaves. Stainless steel plates were implanted at a depth of 0.5 cm. Controls contained no metal plates.

the surface and in front of the plate were significantly higher than at corresponding depths in control experiments without metal implants (level of confidence 1 per cent). The same was true for temperatures behind the plate (level of confidence 2 per cent).

The average temperature increases with the round plate 1.36 cm. in diameter were significantly different at the surface (level of confidence 2 per cent) and in front of the plate (level of confidence 5 per cent). The increase in temperature behind the plate was not significant. In two experiments slight coagulation was observed between the surface and the front of the plate, but none was found behind the plate in any of the experiments. No significant increases in temperature occurred when the round plate 0.68 cm. in diameter was implanted. In each group of experiments included in this series, except the one in which the plate 0.68 cm. in diameter was used, the greatest average temperature increase was at the surface. The increase became less as the depth increased.

Experiments were carried out in which blocks of liver with Glisson's capsule intact were irradiated without Plexiglas covers. The purpose of this was to determine whether the results of the previous experiments could be attributed in part to the Plexiglas containers. Blocks of liver with and without implants of metal (6 by 6 cm. plates) at a depth of 0.5 cm. were irradiated as in the previous experiments except that the electromagnetic waves did not pass through a layer of Plexiglas.

Chart 3 gives a comparison of experimental and control data in this group. The average temperature increases in liver with metal implants were

found to be significantly different from the increases in the controls at each depth (level of confidence 0.1 per cent). Coagulation was found between the surface and the implanted metal plate as well as behind the plate. The greatest temperature increase occurred at the surface, the increase diminishing as the depth increased.

In Vivo Studies. — A pattern of temperature increases following irradiation was established in the experiments conducted in liver tissue in vitro. Since the maximum temperature increases were developed when the 6 by 6 cm. stainless steel plate was implanted at a depth of 0.5 cm., it was decided to implant this plate under the abdominal wall and peritoneum of live rabbits. The thickness of these tissues was approximately 0.5 cm.

Urethane (1.75 Gm. per kilogram) was administered rectally for anesthesia. An incision was made in the midline of the abdomen and the plate inserted under the abdominal wall on the right side. Linen thread was used to suture the incision. The right side of the animal contained the metal, and the left side was used as the control. A total of 32 rabbits was irradiated. Animals 1 through 16 were irradiated first on the right and then on the left side for periods of ten minutes. The procedure was reversed for animals 17 through 32 — that is, the left side (control) was irradiated first and then the right side (containing the metal implant) was irradiated. This was done to determine whether the effects of the first irradiation period influenced the results of the subsequent irradiation of the contralateral side. Temperature measurements were taken immediately before and after each irradiation period. On the side containing the subsequent irradiation of the contralateral side. Temperature measurements were measured. The cutaneous and abdominal temperatures were taken on the control side. The power output used in this series of experiments was 62.5 watts.

The temperature changes produced by the stainless steel plate under the abdominal wall and peritoneum of rabbits and the control for this group are shown in chart 4. The temperature increase both at the cutaneous level and

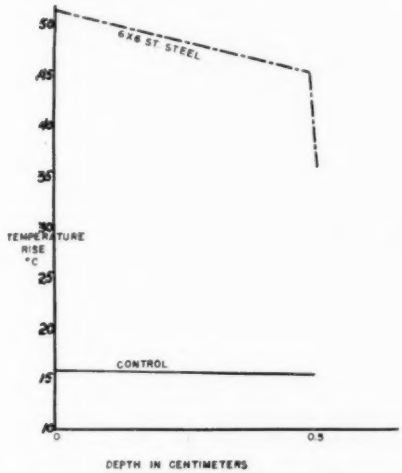


Chart 3. — Temperature increases in liver tissue with Glisson's capsule intact following irradiation with 12.25 cm. microwaves. The stainless steel plate was implanted at a depth of 0.5 cm. Controls contained no metal plate.

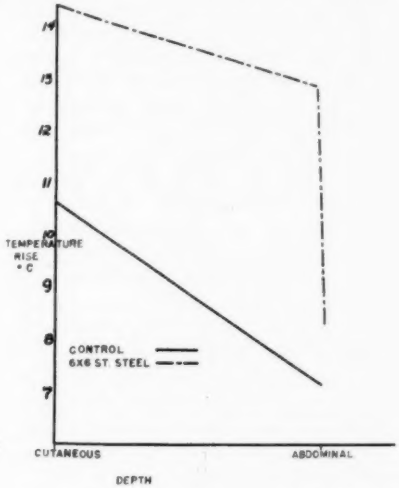


Chart 4. — Temperature increases in the abdominal wall of anesthetized rabbits following irradiation with 12.25 cm. microwaves. The stainless steel plate was implanted under the abdominal wall on the right side, and the contralateral side served as a control.

above the plate was significantly greater than in the corresponding depth in the control area (level of confidence 0.1 per cent). Under the plate the temperature increase was significantly greater than the control, at a level of confidence of 1 per cent. The tissue over the plate was usually edematous

and appeared to be coagulated after irradiation. Edema was also present on the control side of 7 rabbits, but it was less severe than in the side with the stainless steel implant. The greatest average temperature increase was found at the cutaneous level, the increase diminishing with depth. This followed the pattern observed in most of the in vitro liver experiments.

Comment

The effectiveness of the metal implants in changing the heating pattern when the tissue is irradiated with 12.25 cm. waves appeared to vary with the size of the metal and the depth at which it was implanted. An explanation for the extremely high temperatures recorded in some of the experiments in which the metals were implanted at a depth of 0.5 cm. may be found in a reflected standing wave theory. The radiations penetrate the liver and upon reaching the plate are reflected back, setting up standing waves in the tissue between the metal implant and the surface. These energies are added to the original radiations, so that a much greater temperature increase results. Furthermore, a stainless steel plate, being a material with an electrical conductivity of 0.12 that of copper, would itself be heated. This could explain the high temperatures found behind the plate following irradiation, since the heat could be conducted from the plate to the tissue contiguous to it.

In the series of experiments in which the various-sized stainless steel plates were implanted at a depth of 0.5 cm. the temperature increase seemed to vary directly with the size of the implanted plate. This might be expected since the larger the plate, the greater the amount of reflecting surface; hence more standing waves were set up, resulting in a greater increase in temperature. However, when the metal plates were implanted at a depth of 2 cm., the amount of radiations reaching the plate was greatly diminished because of the absorption of the waves by the tissue. Consequently, the small amount of energy which penetrated as far as the plate did not set up many standing waves and, as a result, the temperature increases were not of the magnitude of those found when the plate was implanted at a less depth.

When the plates having a diameter equal to one or one-half times the computed wavelength in liver were implanted at a depth of 2 cm., there was a significant increase in temperature at a depth of 1 cm. and in front of the plate. This indicates that pieces of metal whose diameters either are equal to or are a fraction of the wavelength in the tissues may change the heating pattern. It falls within the realm of possibility that, as machines generating still shorter wavelengths are developed, small pieces of metal, such as are found in the fillings of teeth and in wire sutures, may cause increased heating sufficient to result in tissue damage.

It may be noted that the control pieces of liver irradiated through the Plexiglas had a greater temperature increase than those irradiated without the Plexiglas cover. This may be explained partly by the percentage of reflection of the radiations as they travel from one dielectric medium to another. From the formula $\left(\frac{\mu - a}{\mu + a}\right)^2$, in which a is the square root of the dielectric constant of the first material and μ is the square root of the dielectric constant of the second material, the percentage of radiation lost by reflection when passing from the first to the second material can be calculated. Therefore, when radiations pass from air (dielectric of 1) to Plexiglas (dielectric of 2.75) there is a reflection of 6.2 per cent. When they pass from the Plexiglas into the liver (dielectric of 78), there is added reflection of 43.6 per cent

of the radiations, causing a total reflection of 49.8 per cent of the radiations when the liver was irradiated through the Plexiglas container. However, by similar calculation when the radiations passed from the air to the liver there was a loss of 63.5 per cent of the radiations. This means that theoretically there was a 13.7 per cent greater loss in radiation from reflection when the Plexiglas cover was omitted. This accounts, at least in part, for the more effective heating by irradiation through Plexiglas. The remainder may be accounted for by greater radiation of heat from a free surface than from one covered by Plexiglas.

The temperature increases found in the abdominal wall of the rabbits were not as great as those found in the liver either in the control or in that with the metal plate implanted. In the rabbits, the circulation was intact, so that the circulating blood could remove a considerable amount of heat and thereby dimish the increase which was measured at the end of the irradiation period. In addition, heat was being lost by radiation from the surface of the abdominal wall. Although the power of radiation used was within the safety range recommended for therapeutic use, gross tissue damage, which appeared to be coagulation, was observed in the tissue between the cutaneous surface and the metal plate. This tissue was found to be edematous after the irradiation. This edema was also seen in the control side of some of the rabbits, but the coagulation could not be detected grossly.

Conclusions

1. Under the conditions described in this report, irradiation with 12.25 cm. microwaves caused a greater increase in temperature in tissue containing metal implants than in control tissue.
2. The increase in temperature was of sufficient magnitude to cause gross damage in the tissue contiguous to the metal and between the metal plate and the surface of the tissue.
3. When implanted close to the surface, large metal plates caused greater heating than small ones.
4. The temperature increases were greater when the metal plates were implanted closer to the surface. The increase became less as the depth of implantation became greater.
5. The effects of metal implants depended upon depth of implant and upon the relationship of the size of the foreign body to the wavelength in tissue.
6. With careful use, it seems likely that during microwave irradiation there is little danger of burning a patient who either had metal implanted or metal imbedded in tissue. In most instances the metal is not as large or as close to the surface as described in this report. However, the physical therapist should be cautious in the application of microwave diathermy to tissue containing metal implants.

PROGRESS REPORT *

The Development of the Department of Physical Medicine at the George Washington University Hospital and Medical School, 1948

By Charles S. Wise, M.D., Director,
Department of Physical Medicine,
The George Washington University Hospital,
Washington, D. C.

In April, 1948, the George Washington University Medical School expanded its clinical facilities to include a new four hundred bed hospital. The hospital was begun as a wartime project of the Federal Works Agency. In addition to the services offered at the old University Hospital, special facilities were incorporated to include a department of physical medicine. The equipping of this department was made possible by a generous grant from the Baruch Committee on Physical Medicine. It may be appropriate at this time to outline the plans for the development of physical medicine at this University and Medical School.

The University and Medical School administration is to be commended for considerable foresight and judgment in the planning of this department. From the very outset, they utilized the good services and advice of experts in the field of physical medicine, from the planning of the physical setup of the department to its final equipment. The department is an independent administrative unit within the Hospital and Medical School. Physically it is located on the first floor at ground level, situated so that it is conveniently accessible to both outpatients and hospitalized patients. The wing is divided into seven adequately sized rooms, the largest of which includes six treatment booths. The other rooms are allocated to various types of hydrotherapy — Hubbard Tank, therapeutic exercise room, resistance exercise room, special room for physical tests and measurements and some remaining space, which now serves as a classroom, for future expansion. Adequate storage space, waiting room, offices, and physical therapists' utility rooms are included. The department is under the administration of a full time medical director. When operating at full capacity, the staff will include seven physical therapists. At present there are no plans made for occupational therapy, but it is hoped that in the future space will be made available in another section of the hospital, under the supervision of the department of physical medicine.

It is gratifying to report that the department of physical medicine has enjoyed the full and cordial cooperation of the other medical and surgical services. In conjunction with the department of medicine, the physical medicine department is taking an active part in the development of the arthritic service, under the guidance of Dr. Thomas Brown, Professor of Medicine. The arthritic patients, both ambulatory and hospitalized, are studied carefully in the arthritic service and referred to the physical medicine department as indicated. At weekly intervals the arthritic clinic meets with the director of the department of physical medicine, and the results of the physical therapy received are carefully evaluated. The members of the medical service have shown keen interest in the various technics employed in physical medicine, and various clinical demonstrations have been arranged and will be continued in the future in order better to acquaint the members of the medical service with the various modalities and indications for physical medicine in the treatment of arthritis and related illnesses. It is of interest to report here that many patients who had been seen for some time on the arthritic service, receiving adequate medical care in all respects except for physical therapy, and who had reached a plateau of improvement showed remarkable and sometimes dramatic response to adequate physical therapy regimen. At present a study is being made concerning the effectiveness of gold in the treatment of rheumatoid arthritis in patients who are now receiving physical therapy as compared with those who are not.

In the field of thoracic surgery the department of physical medicine has played an active part in preoperative and postoperative physical therapy regimens for all patients routinely referred to our department as indicated. In cooperation with the surgical service, the department has applied in civilian practice the lessons learned in veteran and army hospitals in regard to preoperative and postoperative physical therapy for persons who have undergone thoracic surgery, and they have been found most satisfactory. The rapid convalescence and minimal deformity in these patients requiring extensive surgical procedures on the chest is self evident.

In the field of physical rehabilitation, the efforts of this department have been somewhat curtailed because of limitations in space and personnel. In selected patients, however, we have worked closely with the District of Columbia Rehabilitation Serv-

(*Continued on page 173*)

* Read at the Twenty-Sixth Annual Session of the American Congress of Physical Medicine, Washington, D. C., Sept. 11, 1947.

ARCHIVES of PHYSICAL MEDICINE

OFFICIAL PUBLICATION AMERICAN CONGRESS OF PHYSICAL MEDICINE

.·. EDITORIALS .·.

AMERICAN BOARD OF PHYSICAL MEDICINE

The next examinations for the American Board of Physical Medicine will be held Saturday and Sunday, June 4 and 5, 1949 at the Jefferson Medical School, Philadelphia. Several Committees of the Board will meet in Philadelphia on April 2 and 3, 1949, to review all applications. Successful applicants for examination will be notified as soon thereafter as is possible. The Secretary is Dr. Robert L. Bennett, Georgia Warm Springs Foundation, Warm Springs, Georgia.

EXPERIMENTAL EVALUATION OF PHYSICAL AGENTS

The past half century has witnessed phenomenal progress in the realm of therapeutics. This has been brought about largely by the application of the experimental method to the evaluation of existing therapeutic agents and to the development of new ones. The relatively new experimental science of pharmacology has, during the past fifty years, caused the deletion from the United States Pharmacopoeia of many worthless drugs and the addition of many new and valuable substances. Outstanding examples of these newer drugs are the barbiturates, the sulfonamides and the antibiotics. No one can doubt the value and importance of this objective critical attitude toward both new and old medicinal agents.

The same approach is essential in physical medicine in order to eliminate empiricism, as rapidly as possible. Our more or less traditional beliefs in the efficacy of certain time-honored physical agents and procedures must not deter us from the most careful and unbiased experimental evaluation of them. New physical agents also must be similarly investigated, before they are entitled to an established place in the armamentarium of physical medicine. It is pleasing to observe that such experimental study is being carried out in various laboratories and clinics.

One of the oldest of physical procedures is massage, which was mentioned in the writings of Hippocrates four hundred years before the beginning of the Christian era. Although it cannot be said that no experimental study has been done to determine the physiologic effects of massage, nevertheless, we need to know still more concerning these effects. As Pemberton[1] has observed, "There is probably no other measure of equal known value in the entire armamentarium of medicine which is so inadequately understood and utilized by the profession as a whole."

We welcome in this issue of the ARCHIVES a study by Wakim, et al.[2] entitled "The Effects of Massage on the Circulation in Normal and Paralyzed Extremities." The findings in this study correct some of our previous ideas

1. Pemberton, B.: Physiology of Massage, Handbook of Physical Therapy, third edition, Chicago, American Medical Association Press, 1939, pp. 78-97.
2. Wakim, K. G.; Martin, G. M.; Terrier, J. C.; Elkins, E. C., and Krusen, F. H.: The Effects of Massage on the Circulation in Normal and Paralyzed Extremities, Arch. Phys. Med. **30**:135 (Mar.) 1949.

of the effects of massage upon the circulation in the extremities.[2] It appears that only the most vigorous massage "results in consistent and significant increases in the average blood flow of the massaged extremity." The authors did find, however, that deep stroking and kneading massage of less severity significantly increased the circulation in the extremities of patients with flaccid paralysis. This report is a valuable contribution to our knowledge of the circulatory effects of massage.

Research to determine the physiologic effects of a new therapeutic agent is also described in the article on microwave heating by Feucht, Richardson and Hines.[3] They found that metals imbedded in the tissues of patients in the microwave field may result in such concentrations of heat that tissue damage may occur. By both in vitro and in vivo experiments these authors demonstrated that metals imbedded in tissues reflect and thereby concentrate microwave energy between the metal surface and the outer surface of the surrounding tissue. The deeper the metal was placed in the tissue the less was the heating effect. The authors state that, with careful use of microwave energy, there is little likelihood that metal imbedded in the tissues of patients would give rise to damage because of the fact that it is usually of small size and more deeply placed than in the experiments described.

Such laboratory studies as those summarized are fundamental to the rational and effective use of the physical agents. The physiatrist, who is familiar with the physiologic action of the physical therapy which he employs, is in the same advantageous position as the internist who has a thorough knowledge of pharmacology. Physical medicine needs much more of this same type of experimental investigation.

3. Feucht, B. L.; Richardson, A. W., and Hines, H. M.: Effects of Implanted Metals on Tissue Hyperthermia Produced by Microwaves, Arch. Phys. Med. 30:164 (Mar.) 1949.

BRACHIAL NEURALGIA

Under this heading Shulman[1] in this issue of the ARCHIVES discusses three causes of pain in the neck and upper limbs, namely: (1) pain caused by osteoarthritis of the costotransverse articulation of the first rib; (2) pain from lesions of the supraspinatus muscle; (3) pain caused by lesions of the cervical spine, such as osteoarthritis.

The three conditions listed may cause local pain and pain referred along the distribution of peripheral nerves. Thus the pain from the first rib region occurs in the first dorsal dermatome on the inner aspect of the elbow and forearm; the pain from the involvement of the supraspinatus muscle in a subacromial bursitis, at the insertion of the deltoid; and pain from the cervical region of the spine, along the distribution of the particular cervical nerve involved. The most interesting of the three types of pain is the last one mentioned.

Radicular radiation from the upper cervical region is back of the ear and over the occipital region; that from the lower cervical region is out over the shoulder and down the arm into the forearm and hand. Radicular pain from the cervical region can frequently be reproduced by manipulation of the head, especially by hyperextension and bending toward the affected side. The writer has seen one instance of phrenic root irritation (cervical 3, 4 and 5) caused by osteoarthritis and resulting in sudden unexpected spasmodic contractions of the diaphragm which interferred with the patients' speech. This could be relieved at will by neck traction with the Sayre head sling. In the dorsal region, radicular pain in the precordial region at the level of the left

1. Shulman, J.: Brachial Neuralgia, Arch. Phys. Med. 30:150 (March) 1949.

third, fourth, and fifth intercostal nerves has been occasionally mistaken for anginal pain. This also may be relieved by traction to the spine, even head traction.

Many patients with osteoarthritis of the cervical spine show no evidence of root irritation. In many of those showing root irritation, however, posterior lipping of the vertebral body into the intervertebral foramina can be detected in the roentgenogram. In the differential diagnosis of these cases, Shulman mentions ruptured intervertebral disc and spina bifida occulta as possible sources of error. Our readers will find this article concise, practical, and interesting.

PROGRESS REPORT

(*Continued from page 170*)

ice and plan some expansion in future facilities along this line. We are seeking the necessary funds for equipping the department with apparatus which will enable us to give more adequate rehabilitation training and treatment, particularly for persons with upper extremity disabilities.

In conjunction with the curriculum committee of the Medical School, plans for a course of instruction in the field of physical medicine have been arranged. It is the consensus of the members of the curriculum committee that the didactic teaching of physical medicine, as well as of other fields of medicine, should be held to an absolute minimum and greater emphasis placed upon clinical experience and demonstration. It is planned therefore that in the second year the medical students will receive a total of sixteen hours of instruction in the basic physical principles as applied to physical medicine. In the third year teaching will be in conjunction with the other phases of medicine and surgery in the form of therapeutic conferences, and physical medicine procedures will be discussed and their application in the treatment of various clinical entities demonstrated. In the fourth year the students will rotate through the department of physical medicine in small groups, of one or two students, at a time for a period of approximately one week, during which time they will obtain first hand experiences and ample observation to orient them toward the scope and application of physical medicine in general medical practice. In the fourth year, eligible students may apply for an eight week elective course in physical medicine, primarily devoted to assisting in a research problem.

In the field of postgraduate instruction, the residents and the intern staff of the hospital have received during the past year, and will continue to receive, short seminars held in the department of physical medicine in which the various modalities are demonstrated and the principal clinical applications of physical therapy are discussed.

To date there has been considerable interest expressed by members of the house staff in regard to further experience in the department of physical medicine. It is hoped that in the future suitable resident training may be made available in conjunction with existing facilities in the District of Columbia and the George Washington University Hospital for specialized training in the field of physcial medicine.

Although there remains a good deal of planning and work to be done to complete the functioning of this department, we feel that a sound working arrangement has been achieved during the first six months, and with the continued cooperation and effort of all those concerned we hope for further expansion of our present facilities. I think that I express, in behalf of the University and the Medical School Administration, as well as in my own, sincere appreciation for Mr. Baruch's generous grant to this department, which has made our present existence possible.

MEDICAL NEWS

Baruch Honored

In recognition of the international influence of his activities in advancing the cause of physical medicine, honorary membership in the British Association of Physical Medicine has been granted to Mr. Bernard M. Baruch, elder statesman and founder of the Baruch Committee of Physical Medicine.

Long concerned with the problems of the physically handicapped, Mr. Baruch in 1944 established the Baruch Committee on Physical Medicine with a grant of $1,100,000 for treatment, training and research in the field in which his father, Dr. Simon Baruch, was one of the nation's pioneers.

Established to meet the major objectives of increasing the number of physicians trained to teach and use physical medicine, providing for more extensive basic and clinical research, and insuring the proper use of physical medicine in relationship to wartime rehabilitation and peacetime preparedness, the Baruch Committee announced last year that its major objectives had been met within five years.

Stating that many members of the British Association on Physical Medicine have received help from the Baruch Committee, Lord Horder, Physician to the King and President of the British Association of Physical Medicine, said in his letter to Mr. Baruch informing him of this recognition: "The impetus and encouragement which your generosity has afforded physical medicine is of international importance."

Dr. Rusk to Give Biggs Lecture

The Hermann M. Biggs Memorial Lecture which is held annually in Hosack Hall at The New York Academy of Medicine under the auspices of the Committee on Public Health Relations will be delivered this year on Thursday, April 7th at 8:30 P. M. by Howard A. Rusk, M.D., Professor and Chairman, Department of Rehabilitation and Physical Medicine, New York University College of Medicine, and Associate Editor, The *New York Times*.

The subject of the lecture will be "The Medical, Social, and Public Health Aspects of Rehabilitation." This lecture is open to the general public.

Dr. Rodriquez Appointed

Dr. A. A. Rodriquez was appointed assistant professor of Physical Medicine at the University of Illinois College of Medicine. His first duties were to take charge of a research program in electrical stimulation of muscles in poliomyelitis patients with a new variable frequency wave generator. The program was sponsored by the National Foundation for Infantile Paralysis and was undertaken under the direction of Drs. A. C. Ivy and H. Worley Kendell.

March Meeting of the New York Society of Physical Medicine

The general theme of the program was the recent progress in the treatment of peripheral vascular disease. "General Advances in Therapy," was presented by Irving S. Wright, M.D. (by invitation); "The Use of Sympatholytic Drugs," by Henry Haimovici, M.D. (by invitation); "Results from the Intra-arterial Infusion of Histamine," by Isidor Mufson, M.D. (by invitation). The discussion was opened by Samuel Silbert, M.D. (by invitation), and William S. Collens, M.D. (by invitation).

Southern California Society of Physical Medicine

The new officers for the Southern California Society of Physical Medicine are: President, James G. Golseth, M.D., Vice-President; Clarence W. Dail, M. D., and Secretary-Treasurer, Lt. Colonel, R. H. B. Dear, MC. The group has been quite active and reports the following meetings held, usually monthly, in the Los Angeles County Medical Society Building: Cerebral Palsy was the subject of one of the meetings held in the Fall, high lights of the annual session of the Congress was presented at another Fall session. At the regular January meeting, there was presented a special symposium on poliomyelitis; for the February monthly meeting there was another fine presentation of a symposium on peripheral vascular disease, with case presentations.

Present plans call for a meeting of the Western Section of the Congress sponsored by the Southern California group, to be held prior to the meeting of the California State Medical Association.

Dr. Wolffe Wins Award

The Laymen's Honor Award of the Pennsylvania Association for Health, Physical Education and Recreation was conferred recently on Dr. Joseph B. Wolffe, of the Wolffe Clinic in Philadelphia. Dr. Wolffe becomes the fifth winner of the annual award, which is restricted to persons not actively or regularly engaged in physical education or recreational work. Dr. Wolffe and his associates conducted an extensive cardiovascular study of athletes.

Postgraduate Center for Psychotherapy, Inc.

The Postgraduate Center for Psychotherapy, Inc., the training associate of the Institute for Research in Psychotherapy, Inc., has been granted a provisional charter from the Board of Regents of the New York State Educational Department. It offers intensive training for psychiatrists in psychotherapy leading to certification; also individual courses for general practitioners and non-psychiatric medical specialists in psychotherapy and psychomatic medicine.

Further information on this program may be obtained by writing to Stephen P. Jewett, M.D., Dean, or to Miss Janice Hatcher, Registrar, Postgraduate Center for Psychotherapy, Inc., 218 East 70th Street, New York 21, New York.

Opportunities in Physical Medicine in the Army

It is possible that in the not too distant future present interns and residents who went through medical school under the Army Specialized Program and have not served in the Army since becoming physicians will be required to serve for a period of active duty. Among these physicians there may be some who are now residents in physical medicine or who intend to enter this field on completion of their internships. Since physical medicine is now firmly established in the Army, there is opportunity for these men to continue working in this field. They will be stationed in one of the three teaching general hospitals. Other physicians may become interested in the field when they realize the opportunity for approved residency training in a general hospital during their tour of duty.

Massachusetts General to Construct Research Building

Massachusetts General Hospital, Boston, announces plans for the construction of a $2,750,000 research building to permit consolidation and expansion of its research program. Construction is expected to start immediately after completion of plans April 1. Research will be conducted in cooperation with Harvard Medical School, Boston, and the Massachusetts Institute of Technology, Cambridge. The new building will contain psychiatry, pathology, cardiovascular and cancer laboratories, clinical laboratories for arthritis and endocrinology and research laboratories for biochemistry, enzyme chemistry, routine chemistry, cellular biology, experimental pathology and physics.

Miss Rouse Appointed Chief of Occupational Therapy

Miss Dorothy Rouse has been appointed chief of occupational therapist of the Veterans Administration Physical Medicine Rehabilitation Service.

Miss Rouse succeeds Miss Jane E. Myers, who has left the government service. A graduate of the Chicago School of Civics and Philanthrophy (Henry Favill School), Miss Rouse has been with VA and its predecessor organizations since 1919. She served at VA hospitals in Minneapolis, Minnesota; Outwood, Kentucky; Murfreesboro, Tennessee, and Oteen, North Carolina. She came to VA's Central Office in Washington, D. C., as assistant chief of occupational therapy in September, 1946.

Dr. Waters Retires

Dr. Ralph M. Waters voluntarily retired as professor of anesthesia in the University of Wisconsin Medical School, January 1. Dr. Waters came to the university in 1926. In 1944 he was awarded the Hickman Medal by the Royal Society of Medicine of London, and in 1947 the King of Sweden conferred on him the Order of Vasa for training Swedish doctors at the Wisconsin General Hospital. In 1946 he was awarded the Cutter Medal of the Phi Rho Sigma Fraternity, and he was the first recipient of the Distinguished Service Award by the American Society of Anesthesia.

Free Cerebral Palsy Treatment

The Dallas Society for Crippled Children is operating a cerebral palsy treatment center for children at no cost to their families. The medical staff is composed of twelve doctors whose service is free of charge. The doctors also give courses for parents and a series of fifteen lectures which explain the cause of cerebral palsy and treatment. Operating funds come from the sale of Easter Seals, the Dallas Junior League and miscellaneous donations. Three nurses' training schools in Dallas, the Southwestern Medical College and Southern Methodist University Medical Department send their students to the center to work.

Certification of Radiation Physicists

Beginning January 1, the American Board of Radiology will examine and certify physicists as radiation physicists. Three types of certificates will be granted: (1) radiological physics, (2) x-ray and radium physics and (3) medical nuclear physics. The second and the third are both included in the first. Each applicant for any one of the certificates in radiation physics will be required to meet several standards of education and experience. Certification will be based on examination to be conducted at the time and place of regular meetings of the American Board of Radiology. Information may be obtained from Dr. Byrl R. Kirklin, Mayo Clinic, Rochester, Minn.

Association for Physical and Mental Rehabilitation Convention in May

The Association for Physical and Mental Rehabilitation will hold its Third Annual Convention at the Hotel New Yorker, New York City, May 18-21, 1949.

New Appointment for John S. Laughlin

John S. Laughlin, Ph.D., who has been associated with the cyclotron and betatron projects at the Urbana campus of the University of Illinois, has been appointed assistant professor of radiology and radiation physicist at the University of Illinois College of Medicine, Chicago.

Centers for Rehabilitation of Disabled Growing in U. S.

According to The Baruch Committee on Physical Medicine, there are 150 communities in the United States which have, or are in the process of organizing, community rehabilitation centers. The emphasis placed on the development of such facilities since the war is an example of how the lessons learned in wartime can fruitfully be applied to the needs of peacetime. — Rusk, N. Y. *Times.*

Apparatus Accepted

Microtone Audiomatic, Model T-5, Hearing Aid.— The Microtone Audiomatic, Model T-5, Hearing Aid is a battery-contained type of hearing aid. A rectangular case of white plastic material contains microphone, amplifier and batteries. The Council on Physical Medicine voted to include this hearing aid in its list of accepted devices.

Liebel-Flarsheim Model AG Bovie Electrosurgical Unit. — The Liebel-Flarsheim Model "AG" Bovie Electrical Unit is designed to succeed the Improved Davis-Bovie Electrosurgical Unit manufactured by the same firm and on the accepted list. The Council on Physical Medicine voted to include this unit in its list of accepted devices.

Health Bills Jam Hoppers of Senate and House

Approximately fifty medical research and public health bills were introduced in the first three weeks of the new Congress. Nine of the measures authorize a federally sponsored campaign of research in multiple sclerosis. That efforts will be renewed in this Congress to create federal service positions for chiropractors is indicated by the early introduction of H. R. 1512 which authorizes their appointment in Veterans Administration. Its sponsor is Rep. Walter B. Huber (Democrat) of Akron, Ohio, who says he filed the bill at the request of the Veterans of Foreign Wars. It is similar to a measure introduced last year by Rep. James T. Patterson (Republican, Conn.) but which was pigeonholed in the Veterans Committee. Senator Johnson of Colorado introduced S. 458, which provides for a nationwide survey of physically handicapped persons. This measure was drafted by the American Federation of the Physically Handicapped, which also plans to support legislation on cerebral palsy, epilepsy and leprosy.

Scientific Assembly of Academy of General Practice

The first annual scientific assembly of the American Academy of General Practice was held in Cincinnati at the Netherland Plaza Hotel, March 7-9, 1949, under the presidency of Dr. Paul A. Davis, Arkon, Ohio. Among the program participants was Howard A. Rusk, New York, who spoke on "Role of the General Practitioner in Rehabilitation of the Patient with Chronic Disease" and Herman G. Weiskotten, Syracuse, who talked on "Medical Education and Its Relation to General Practice."

International Congress of Ophthalmology

The Sixteenth International Congress of Ophthalmology will be held in London under the presidency of Sir Stewart Duke-Elder, July 17 to 21, 1950. Any qualified medical practitioner may become a member. Relatives and friends of members will be welcomed as associate members and may attend the opening and closing ceremonies and all social functions. The official languages are English, French and Spanish, but any language may be used.

The Kenny Institutute

The Sister Kenny Institute in Minneapolis, founded in 1942 at the Lymanhurst Hospital, has undergone a reorganization of its staff. With the appointment of Dr. Edgar J. Huenekens, pediatrician of Minneapolis, as chief of staff of the institute last August, the addition of Dr. Miland E. Knapp as chief of physical medicine in charge of treatment and training of physical therapists, also of Dr. John F. Pohl as consulting orthopedic surgeon, Dr. Sigsbee R. Seljeskog and others, the institute is assured of first class professional supervision.

BOOK REVIEWS

ATHLETIC INJURIES. By *Augustus Thorndike*, M.D., Chief Surgeon to the Department of Hygiene and to the Harvard Athletic Association, Harvard University; Associate in Surgery, Harvard Medical School. New (3rd) edition. Cloth. Pp. 243 with 114 illustrations. Price, $3.75. Lea & Febiger, Washington Square, Philadelphia 6, 1948.

Dr. Thorndike's monograph on athletic injuries deserves the attention of those associated with organized sports. Its practicability and simplicity make it an excellent manual for the coach and trainer as regards prevention of injuries, strapping, taping, training principles, etc. For the physical therapy technician treating athletic injuries it is essential reading material. Its value as a therapeutic guide and manual embraces a larger scope than described by its author, for much of it is directly applicable to prevention and care of industrial injuries. A physician charged with the responsibility of a team's welfare can ill afford to be without the information in this book.

The brevity of the book is not due to incomplete coverage of the subject by the author but to his ability to say much in a few words. His approach to the subject is direct, his dealing with the subject is deliberate, concise, and without an element of dogmatism. Much of the brevity and clarity of presentation of the text is due to the approximately 157 charts, tables, graphs, drawings and photographs.

The chapter on physical fitness is excellent, especially the newly edited section on physical fitness testing. Here the physiologic principles of the muscular, respiratory and circulatory systems necessary for an understanding of the development and maintenance of physical fitness are presented. The step test is described.

The author has divided the book into three parts. First it is concerned chiefly with prevention of athletic injuries and the many factors incident to it; for example, physical fitness, proper equipment (its protective value, effectiveness in permitting heat loss, etc.), protective strapping, prophylactic exercises, "pep" pills, etc. The second section gives the type of injury sustained in athletics, their incidence and pathologic nature. The rise in days of play expectancy is presented graphically and offers concrete evidence for the necessity of a scientifically controlled athletic program. The second section is a reference book which includes the diagnosis and treatment of the more common injuries. It is here in particular that the reader can benefit so much from the author's many years of experience in the handling of athletic injuries. They are the experiences and viewpoints of a well-known surgeon with wide experience in handling of injuries on the athletic field and through the period of convalescence. It is a book containing carefully collected data over a long period of years. The soundness of the principles of training and treating the athlete given by the author are attested to not only by the results obtained by himself but also by others who have followed them.

FRACTURES AND DISLOCATIONS. By *Edwin O. Geckeler*, M.D., F.A.C.S., Fellow of the American Academy of Orthopaedic Surgeons, Fellow of the American Association for the Surgery of Trauma, Diplomate of the American Board of Orthopaedic Surgery. Fourth Edition. Fabrikoid. Price, $5.00. Pp. 383 with 344 illustrations. The Williams & Wilkins Company, Mt. Royal and Guilford Aves., Baltimore 2, Maryland, 1948.

This is a book intended for the general practitioner and student. It is a practical, straight forward presentation with omission of numerous and complicated methods of treating fractures and dislocations. The author in most instances describes only one method and from his vast experience it is undoubtedly the one that is most useful for these disorders. The first chapters discuss the general considerations for fractures, including the management of shock, wounds, reduction and follow up treatment in which physical methods are briefly mentioned. The subsequent chapters consider fractures of the different bones of the body in a logical and concise manner as to examinations, prognosis, treatment and precautions. The illustrations are particularly good, including the roentgenographic reproductions and the line drawings. This is the fourth edition and the sixth printing. Its popularity has been justified. The busy physician will find it to be a helpful, concise and up to date book.

PROVISIONS FOR PERMANENT DISABILITY. By *Carl W. Strow*, Ph.D. Paper. No price. Pp. 10. Research Council for Economic Security, 111 W. Jackson Blvd., Chicago 4, 1948.

This is one of a series of publications sponsored by the Research Council whose purpose it is to disseminate knowledge about social security. The problem of those disabled permanently in the United States is briefly considered and how the situation has been managed in other countries, especially Germany and Great Britain before the war. The author cites a few of the states, notably Wisconsin that have worked out a system in this field which, according to him, may be feasible but also has limitations. He believes this requires a "national system" and discusses the possibility of inclusion of permanent disability under Federal Old Age and Survivors Insurance.

CHRONIC STRUCTURAL LOW BACKACHE DUE TO LOW-BACK STRUCTURAL DERANGEMENT. By *R. A. Roberts*, B. Sc., M.B., Ch. B. Cloth. Price, 45s. Pp. 105, with 137 illustrations. H. K. Lewis & Co., Ltd., 136 Gower St., London, W. C. 1, 1947.

This is an interesting discussion of low back pain. It contains chapters on defective ossification of the pars interarticularis, spondylolisthesis, spondylolysis, unilateral spondylolysis, upper lumbar defects, radiologic evidence of defects of ossification in the articular processes; cases with various radiologic changes; cases with no definitely recognizable radiologic changes; significance of defects of ossification in the neural arch; significance of the histories of chronic backaches; significance of edema in overstrained soft tissues; neurovascular and "visceral" symptoms; low-back structural derangement; treatment from structural aspect.

This is a foreign publication. Attention is called to the quotation: "Let us make use again of the wisdom and experience of Paul B. Magnuson — 'The symptoms of backache with referred pain along the course of the sciatic nerve has for many years attracted the attention of orthopaedic surgeons and industrial surgeons everywhere. Looking back at the evolution in the diagnosis of this condition over a period of 35 years, one cannot help but remember the old days when the diagnosis of railroad spine was made in those cases where an injury occurred at the onset of backache was not infrequently followed by sciatic pain. This diagnosis was due to the inability of the medical profession to comprehend the underlying pathological changes which can happen in the lower back'."

The medical profession should read this book. It ends with this sentence: "There is a strong case for a reconsideration of our attitude to these cases who suffer from 'our inability to comprehend the underlying pathological changes' before they join the swelling ranks of so-called psychosomatic disorders."

PRIMARY ANATOMY. By *H. A. Cates*, M.B., Professor of Anatomy, University of Toronto. Cloth. Pp. 478, with 392 illustrations. Price, $6.00. Williams & Wilkins Company, Mt. Royal and Guilford Avenues, Baltimore 2, Maryland, 1948.

This new anatomy text is designed for the increasing body of ancillary medical personnel such as physical and occupational therapists, nurses, and physical educationists. The various systems, bony, muscular, circulatory, etc., are taken up independently together with something of the embroyology and also a little fundamental physiology or function. These three systems are developed in more detail than the visceral anatomy, a point of interest in relation to physical therapist and occupational therapist. The line drawings, so important in an anatomy text, are simple, diagrammatic and clear.

This is recommended as an adequate text for other than medical students and is perhaps better adapted for use with prepared specimens than as an aid in the dissecting room.

HEALTH INSTRUCTION YEAR BOOK, 1948. Compiled by *Oliver E. Byrd*, Ed. D., M.D., F.A.P.H.A., Professor of Health Education and Director, Department of Hygiene, School of Education, Stanford University. Foreword by Ray Lyman Wilbur, M.D., Chancellor, Stanford University. Cloth. Price, $3.50. Pp. 320. Stanford University Press, Stanford University, California, 1948.

This is the sixth of the series of current information culled from health articles published during the year. The editor states that he has read 1,514 articles to select the 321 chosen for consideration and publication. In terms of total selections, the *Journal of the American Medical Association* lead with a total of 43 abstracts; the *Congressional Record* with 19 abstracts was next and the *American Journal of Public Health* with 15 abstracts; the ARCHIVES OF PHYSICAL MEDICINE had one article abstracted (Ultraviolet Air Disinfection by Anderson). The subjects covered ranged from Abortion Paste Deaths through Bed Rest, California's Prenatal Law, Gamma Rays to Vaccines, Vampire Bats, War Time Marriages World Medical Association to X-Rays, presented in 21 chapters and again followed by a full bibliography, list of sources, author and subject index. This is not only a volume of outstanding general interest but also constitutes a new type of textbook, permitting a very flexible and current approach to the teaching of hygiene.

ESSENTIALS OF FEVER. By *Gerald E. Breen*, M.D., B.Ch. (N.U.I. Dub.); D.P.H., D.O.M.S. (R.C.S. Eng.): Tempy. Divisional Medical Officer, Hospitals Division, The London County Council; Late Municipal Medical Representative and Deputy Sector Hospital Officer, E.M.S.; Formerly Deputy Medical Superintendent, The L.C.C. Infectious Hospital Service; Examiner in Fevers to the General Nursing Council of England and Wales. Second Edition. Cloth. Pp. 352, illustrated, including 16 colored plates. Price, $4.50. Williams & Wilkins Co., Mount Royal and Guilford Aves., Baltimore 2, 1948.

The practical knowledge of fevers, meaning the acute infectious diseases is not as general as may be desired and the author of this pocket-size volume offers in it the essentials of theory, treatment, management and prophylaxis. He also includes sections on preventive nursing and isolation, elementary epidemiology and the law as to infectious disease and, wherever practicable, a note on preventive inoculation and the control of outbreaks. After the favorable reception of the first edition he added in this edition new sections on typhus, glandular fever, undulant fever, influenza and encephalitis lethargica, as well as "notes" on sore throat and food poisoning. There

also have been added 15 color plates, partly diagrammatic, on the appearance of the skin and mouth in typical fevers while 22 other figures and charts aid further visualization and differential diagnosis. Students of medicine and young practitioners should find the well presented material of this volume quite helpful.

DETAILED ATLAS OF THE HEAD AND NECK. By *Raymond C. Truex*, M.S., Ph.D., Associate Professor of Anatomy, College of Physicians and Surgeons, Columbia University and *Carl E. Kellner*, Artist, Department of Anatomy, College of Physicians and Surgeons, Columbia University. Cloth. Pp. 162, Illustrated. Price, $15.00. Oxford Medical Publications. Oxford University Press, 114 Fifth Avenue, New York 11, N. Y., 1948.

This outstanding atlas of the head and neck must be a source of great pride not only to the anatomist and artist but also to the publisher. This is a work of art. Most of the drawings are colored and drawn to scale, and were made from origin regional dissections. The figures portray serial dissections from superficial to more deeply placed layers preserving a continuity of the important structure within each region. This sequence permits a continued review of the structures traversed or actually removed in the coarse of dissection. This technic has been consistently followed through the neck, face, brain, spinal cord, orbit, ear, pharynx, mouth, larynx, nose and paranasal sinuses. In addition, the axilla and thorax were sufficiently exposed to demonstrate the continuity of the organs, vessels and nerves of the neck into these regions.

The series of frontal and transverse sections are unique in the detail with which they portray the anatomy of the brain in relation to investing tissues of the head. These should be invaluable to the neurologist and neurosurgeon.

The student can readily find all the pictorial aids that he needs to reconstruct a three dimensional view of a given region. This excellent work should be valuable to every medical student and surgeon. The physiatrist and physical therapist will find this work invaluable. Every school of physical therapy should have the atlas in the library. The authors deserve great credit for the production of such an excellent atlas both from the teaching and artistic point of view.

POLIO AND ITS PROBLEMS. By *Roland H. Berg*. With a Foreword by Basil O'Conner, President, The National Foundation for Infantile Paralysis, Inc. Cloth. Pp. 164 with 24 illustrations. Price, $3.00. J. B. Lippincott Co., 227 South 6th St., Philadelphia 5, 1948.

This is a book intended for laymen and can be recommended unreservedly for such reading. It could also interest professional men and other persons allied with medicine, for it is an accurate and stimulating account of many of the problems concerning poliomyelitis. The author brings out particularly the research efforts that have been made in an attempt to find the cause of the disease. The author does this in good style, without resorting to the sham dramatics that so many other authors believe necessary in writing for lay consumption. The treatment of the disease is reported with enough information to be correct and interesting but without being technical. Many forms of therapy are merely mentioned wheras a few are described with more detail. An example is the Kenny treatment which obviously even at this date should concern nonprofessional individuals and would thus call for some discussion. Certainly the author has been fair and the facts he tells about should offend no one. Physical medicine's part in the care of the polio patients is amply covered and its value justly credited. Several physiatrists are quoted favorably. Dr. Robert Bennett is singled out particularly for well earned honors. This is an intelligent and informative book which is a credit to the author.

THE HOSPITAL PURCHASING FILE. Twenty-Sixth Edition. Boards. Various Pagination with Illustrations. Hospital Purchasing Files, Inc., 919 N. Michigan Avenue, Chicago 11, Ill., 1949.

This book is an excellent reference on hospital buying. It contains an alphabetical list of manufacturers and distributors, a directory of hospital products and a group of twenty-one manufacturers' catalogues classified on a departmental or service basis. This book is an excellent source of information and reference for those who are concerned with the services of supply, hospital operation and maintenance.

AN INTRODUCTION TO PHYSICS IN NURSING. By *Hessel Howard Flitter*, R.N., M.A., Head of Nursing Science Department, School of Nursing, University of Pennsylvania, Philadelphia; Instructor in Education, Hunter College of the City of New York, New York City; Formerly Instructor of Physics Applied to Nursing, New York University, School of Education, New York City. Paper. Price, $3.35. Pp. 179, with 100 figures. The C. V. Mosby Company, St. Louis, 1948.

This treatise is not encyclopedic in scope and is not offered as a thorough comprehensive course in elementary physics as might be given to science majors and engineers. It is a compilation of some of the most basic principles of physics and their applications to physiologic processes, hospital situations and everyday life. The subject matter is presented and designed to develop an understanding and appreciation of those principles of physics and the relationship of these principles to nursing and to physical medicine.

PUBLIC HEALTH ADMINISTRATION IN THE UNITED STATES. By *Wilson G. Smillie*, A.B., M.D., Dr. P.H., Professor of Public Health and Preventive Medicine, Cornell University Medical College, New York. Third edition. Cloth. Price, $6.50. Pp. 637, with 43 illustrations. The Macmillan Company, 60 Fifth Ave., New York 11, 1947.

Public Health Administration in the United States is in the developmental stage and presents a highly complex picture owing to the multiformity of public health practices in the various official Federal, State and local agencies as well as in diverse voluntary agencies. The author holds that if public health administration is to assume a real place in the scientific application of knowledge, it must be based on the principles of preventive medicine. These principles are changing constantly with the accretion of new knowledge. Thus public health must be dynamic, not static. The health officer should be free to try out new methods, and more important still, to discard old practices that are unfruitful. In the third edition of his volume the author again presents those public health administrative methods that have been employed by competent, experienced men and that have the merits of successful application. Important changes include new information regarding control methods for scarlet fever and the streptoccic pneumonias, tuberculosis, and particularly the control of syphilis, together with the other venereal diseases; control of malaria, tetanus, epidemic cerebrospinal meningitis, influenza and the range of acute infectious diseases; new control measures in environmental sanitation; new concepts of communicable disease control, geriatrics, economic aspects of nutrition, health education, and social health programs. The index adds to the comprehensiveness of this authoritative and well written volume.

PHYSICS FOR ARTS AND SCIENCES. By *L. Grant Hector*, Vice-President and Director of Research and Engineering, Sonotone Corporation; *Herbert S. Lew*, University of Buffalo, and *Clifford E. Scouten*, Formerly of the University of Buffalo. Pp. 731, illustrated. Cloth. Price, $5.50. The Blakiston Company, 1012 Walnut Street, Philadelphia 5, 1948.

The presentation of material in this text, written for beginners is based on the assumption that the physical world in which we live can be largely explained by mechanical and electrical concepts. Included in the general field of mechanics are the behavior of ordinary material objects, also the subjects of heat and temperature, the behavior of sound, and many molecular phenomena. In the broad field of electricity are included the ordinary behavior of electricity and also the subjects of magnetism and light. Light is shown to be electrical in nature, but the geometric optics associated with practical applications are also given. At the end of the text the general subject of nuclear physics is presented. The authors prefer to use the concrete reasoning approach, so as to develop the student's appreciation of the nature and methods of science. A very commendable feature is an overall view as an introduction to each chapter. It gives the reader some idea of what to look for in the pages that follow. At the end of the chapter, the principal ideas developed are listed and a central thought summarizing the chapter is given. Another feature of the text is the use of color in the line drawings. In general the material parts are represented in black, the special, pertinent features being depicted in red. For example, the iron of electromagnet would appear in black lines, the electric currents in red. The beginner's attention is much more readily fofused on the special features in these drawings than in ordinary all-black figures. This is an up to date volume which should be of definite value to medical students, physical therapy technicians and all physicians necessarily interested in physics.

INTRODUCTION TO HEALTH EDUCATION. By *Jackson R. Sharman*, Ph.D., Professor and Head of Health Education and Physical Education, University of Alabama. Fabrikoid. Pp. 273. Price, $3.00. A. S. Barnes & Company, Incorporated, 67 West 44th Street, New York 18, N. Y., 1948.

This book should prove useful as an elementary text in the subject of health education and introductory physical education. There are study questions with each chapter and an up to date bibliography.

HEBREW MEDICAL JOURNAL (Harofe Haivri), Volume II, 1948. Published at 983 Park Avenue, New York 28, N. Y.

With the constitution of a separate State for Israel and the excellent medical work already being carried on there, Hebrew Medical literature should assume an increasing importance in the years to come. With the appearance of this volume, the *Hebrew Medical Journal*, edited by Moses Einhorn, M.D., concludes its 21st successful year of publication. The aim of this journal, is to meet the need for a medical journal written in Hebrew, with English summaries, thus aiding greatly in the advancement and development of Hebrew medical literature. This issue contains an article on hypertensive vascular disease by Benjamin Jablons, M.D. There is also a discussion on clinical observations and treatment of 190 cases of malaria in Palestine by Dr. P. Ephrati of Tiberias. In addition, under the heading of "Personalia," biographical sketches of Professor Heinrich Finkelstein, great pediatrician; Professor Max Neuburger, renowned medical historian, and Dr. Solomon Solis-Cohen of Philadelphia, are presented.

PHYSICAL MEDICINE ABSTRACTS

Rehabilitation in Rheumatoid Arthritis. Stafford L. Osborne.

Northwestern Univ. Bull. Med. School **22**:340 (Winter Quarter) 1948.

Physical therapy is one of the most important single factors in the treatment of chronic rheumatoid arthritis. Nevertheless, it should not be forgotten that physical therapy is merely an adjunct to other treatments. Used without discrimination, physical therapy may cause harm. Physical therapy alone does not cure arthritis, and used to the exclusion of other antiarthritic measures, will not produce maximal results. The role of physical therapy is an essential one in the treatment of all joint conditions and the care with which this form of treatment is planned may determine the time element in the progress of those difficult cases. Supervision of the patient by a physician well trained in the treatment of rheumatoid arthritis is a first essential to gain the desired therapeutic results. His expert guidance is necessary to maintain the proper balance between rest and activity. The protection, expert instruction and the grading of treatment by the physical therapist under the physician's direction, can and does shorten the period of illness. It may be the important factor in recovery.

Poliomyelitis: Effect of Exertion During the Preparalytic Stage. E. R. Hargreaves.

Brit. M. J. **4588**:1021 (Dec. 11) 1948.

A history of great physical exertion immediately preceding the onset of severe paralysis in attacks of poliomyelitis has often been recorded, but until recently no statistical evidence was available to determine whether such instances were more frequent than chance would dictate. The effect of physical or mental exertion during the preparalytic stage of poliomyelitis on the ultimate prognosis is analyzed in thirty cases of the disease which occurred in Cornwall during 1947-48. The observations show that severe physical activity during the preparalytic stage is associated wih grave prognosis. Severe mental strain, such as driving a car over long distances, appears to be equally disastrous, whereas paralysis tends to be mild in cases confined to bed during the preparalytic stage.

The Care of Paraplegic Patients in General Hospitals. Eric Rogers.

Canad. M. A. J. **59**:338 (Oct.) 1948.

One of the aims of physical therapy in a general hospital is to prevent contractures and muscular deterioration, particularly of the arm and upper trunk musculature. It is the responsibility of the physical therapists to see that a foot board is constantly in place to prevent the pressure of bedding causing foot contractures. As soon as the patient's general condition permits, simple reconditioning exercises should be done under supervision twice daily. Gradually the schedule should be expanded to include rolling from side to side, resistance pulls against weights on pulleys and trunk lifting by means of overhead bed bars. The active physical therapy department at the Ottawa Civic Hospital organized wheel chair and mat classes. However, if the general hospital patient is able to engage in these activities, he is ready for transfer to the paraplegic center.

Electrodiagnosis in Peripheral Nerve Lesions. Sam D. Graham.

U. S. Nav. M. Bull. **48**:838 (Nov.-Dec.) 1948.

The newer electrodiagnosis machines with their rectangular wave galvanic current giving accurate reproducible data, have become a great aid in diagnosing and following the course of degeneration, denervation and regeneration. Many of Erb's original observations in his "reaction of degeneration" are still used in testing for nerve lesions, although his observations have been elaborated on. Certain characteristics for degeneration, denervation and regeneration have been outlined and have been used to follow the state of innervation with good success.

Some Modern Aspects of the Treatment of Bulbar Poliomyelitis. H. D. Bouman, and K. B. McDonough.

Wisconsin M. J. **47**:1099 (Nov.) 1948.

It will be clear that in the patient with bulbar spinal polioymelitis, the bulbar symptoms should dominate the therapeutic picture. Nobody will deny the importance of early physical therapy in spinal poliomyelitis. Insistence on the treatment of spastic or paralytic leg muscles when the patient's life is at stake can hardly be considered sound medical practice. This goes particularly for hot packing. Hot packing requires handling of the patient and sometimes produces postures which are not ideal for early respiration. Use of hot packs may increase the oxygen requirements of the body, and if the patient suffers from hypoxia this would be undesirable.

Tube feedings should be avoided during the acute illness and should not be attempted until the temperature has remained normal for forty-eight to seventy-two hours and progression of paralysis has ceased. Earlier use of tube feedings is contraindicated because of the tendency of these patients to vomit.

When the patient is able to swallow his own saliva, sips of clear water and diluted fruit juices may be started. If no choking or regurgitation occurs, clear broth, apple sauce, Jello, and junket may be gradually added. Milk is best avoided in the early stages of recovery because it tends to stick with mucus in the mouth and pharynx.

A word of caution should be said about the transportation of patients with evidence of bulbar paralysis. If such a step is necessary to obtain adequate treatment for the patient, he should be accompanied by a physician or nurse who has facilities available for the aspiration of mucus and the administration of oxygen. Such professional administration will help considerably to relieve the apprehension of the patient and perhaps save his life.

Rehabilitation in Industry. L. W. Plews; John N. Barron; A. R. Thompson, and H. H. Newell.

Lancet **255**:699 (Oct. 30) 1948.

For the provision of remedial movements highly skilled operations are completely unnecessary. By far the most valuable machine-tool is the single-spindle drilling machine. By adding special equipment to the operating lever most movements can be obtained for hands, arms, and shoulders. Other exercises for upper limbs are provided by the bending of copper and steel pipes round formers at the bench. Bending a ¾ inch steel rod by pulling on a 5 foot bar gives an easy rowing motion which promotes development of the main trunk muscle groups. It is obvious that physical therapy is a necessary and important adjunct to an industrial project of this kind. Here there is a modern well-equipped unit employing a whole-time staff. It is situated close to the retraining shop, and this proximately suggests the importance attached to the close cooperation between them. From the physical therapy point of view it must be admitted that the ability to rely on long periods of controlled active exercise in the shop (42½ hours a week) is a great advantage. On the other hand, orthodox physical treatment is found necessary in 60 per cent of cases.

Clinical Assessment of Peripheral Nerve Injuries: Tinel's Test. W. R. Henderson.

Lancet **255**:801 (Nov. 20) 1948.

On the basis of Tinel's test, nerve injuries fall into four clinical groups. It is assumed in the following description that there has been sufficient time for fibers to grow at least several inches along the distal segment.

Group I: No Regeneration. — Tapping on the nerve lesion (pathologic type 1) produces tingling which is mild during the first few weeks and then becomes stronger when the sprouting axons are more exposed inside the neuroma. (The reverse of this is seen in the almost complete disappearance of response at the suture line immediately after resection of a tender neuroma.)

Group II: Negligible Regeneration. — In many severe (mixed) lesions, which to the naked eye resemble those in group I, a few stray fibers succeed in passing the obstruction in a lesion-in-continuity, or in bridging a gap of several inches. The sensation from the neuroma is virtually as strong as in group I, but tingling can also be obtained from the distal segment, though it is weak.

Group III: Partial Regeneration. — These intermediate cases show a wide range of partial recovery, varying from slight to good. All three types of fiber damage may be present (and perhaps also fibers undamaged or originally affected by neuropraxia). There is likely to be a preponderance of type III (axonotmesis) after a slight injury, whereas more severe lesions contain only types I and II, as after suture.

Group IV: Complete Regeneration. — When all the fiber sheaths are intact, percussion of the dense wave of unmyelinated axon tips advancing simultaneously along the nerve produces as strong a sensation as the neuroma response does in groups I and II. There is a delay of one or two months before this advance is detectable, and then it progresses about 3 inches a month.

The Possibilities of Physical Medicine from the Standpoint of the Internist. George M. Piersol.

Bull. Chicago M. Soc. **51**:417 (Dec. 11) 1948.

The paraffin bath, in which the part is repeatedly immersed in or painted over by melted paraffin until a protective coating is established, is an excellent method of obtaining prolonged effects of a high surface temperature. It has been shown that skin temperature under such a coating of paraffin may be around 116 F. The paraffin bath affords an even distribution of heat, leaves the skin soft and pliable, relieves pain and swelling, and is particularly useful in arthritis of the hands and feet.

The whirlpool bath is one of the most effective forms of treatment in the management of arthritis involving the extremities. The temperature of whirlpool baths is usually maintained between 100 and 110 F. Since the water is kept constantly aerated and in motion by mechanical agitation, the effect of gentle and continuous massage is added to that of heat.

Pemberton regards massage as the most valuable procedure in the treatment of arthritis. He believes that properly applied massage does good in chronic arthritis in four ways. It helps to prevent or delay atrophy in muscles and in the restoration of muscle tissues when atrophy has already occurred, it improves the general and local metabolism; it increases the amount of circulation of blood to certain tissues and facilitates the return to the circulation of man's corpuscular elements tucked away in inactive regions and it lessens local edema by mechanically bringing about the effects normally exercised by muscles in aiding the heart to empty the venous circulation.

The importance of exercise in maintaining mobility of the joints in various cases of chronic arthritis has long been recognized. A large part of the disability which occurs in patients with rheumatoid arthritis is the result of muscular atrophy, contractures and ankylosis of joints. This is largely preventable by the institution early in the disease of a suitable exercise program. During the acute stage of rheumatoid arthritis or any joint disease a period of bed rest is essential, but this period should be as brief as possible. Even if the patient is confined to bed the value of exercise should not be overlooked. In addition to the use of heat and massage above referred to, patients should be taught muscle setting exercises which should be performed by the patient several times a day Bed exercises of the uninvolved portions of the body should be carried out regularly every day so as to prevent general atrophy and the other ill effects of prolonged inactivity.

Rehabilitation and General Practice. Howard A. Rusk.

J. A. M. A. 139:14 (Jan. 1) 1949.

The practice of rehabilitation for the general practitioner, or for any physician, begins with the belief in the basic philosophy that the doctor's responsibility does not end when the acute illness is ended or operation is completed; it ends only when the patient is retrained to live and work with what is left. This basic concept of the doctor's responsibiliy can be achieved only if rehabilitation is considered an integral part of medical service. Any program of rehabilitation is only as sound as the basic medical service of which it is a part. The diagnosis and prognosis must be accurate, for it is on them that the feasibility of retraining is determined.

In rehabilitation, as in definitive medical care, the general practitioner is an essential and integral member of the therapeutic team. Today, as new and mounting demands are made on him to restore his patients to maximum economic and social effectiveness, he must turn to the expanding field of rehabilitation and physical medicine for increased technical skills and assistance. However, he can apply many of these simple technics directly in his office, home and hospital practice to help his physically disabled patients "learn to live and work with what they have left."

Efficacy of the Suppository and of Jelly Alone as Contraceptive Agents. N. J. Eastman, and Robert E. Seibels.

J. A. M. A. 139:16 (Jan. 1) 1949.

One of the greatest obstacles to the prescription of contraceptives by physicians has been the belief that the diaphragm with a spermicidal jelly or cream is the only reliable method which the patient herself can employ. With this in mind, the physician recalls also the time-consuming features of fitting a diaphragm and instructing the patient in its use and as often as not sidesteps the whole issue by omitting any form of contraception from his armamentarium. This contraceptive method described was developed to meet some of the disadvantages of the sheath, especially the frequent unwillingness of the man to use it. It had the further advantage of putting the control of contraception in the hands of the woman, which was logical, as she was more available for education and more aware of the necessity; since she is the great sufferer from an unwanted pregnancy, it was supposed that she would be more willing to learn the method and to use it regularly.

It may be that certain women, highly skilled in the insertion of the diaphragm, will receive better protection from that technic, but surely mass studies on the diaphragm have not shown greater efficacy than is reported in this paper by simpler procedures. Hence, the conclusion would seem inescapable that these methods, especially the suppository, the simplest of them all, deserve more widespeard trial than they have heretofore received.

Electromyography. P. Bauwens.

Brit. J. Phys. Med. 11:130 (Sept.-Oct.) 1948.

It may well be possible in future to standardize recording technic and terminology to such an extent as to make examinations by a technician practicable, but the time has not yet come. Bauwens believes that this clinical application of electrophysiology has great potentialities, but that the value of its contribution to neurology will depend in a large measure on how we'l it is supported during its developmental stages by the tripod made of the neurologist, the neurosurgeon and the morbid pathologist. Each of these can confirm or reject a tentative diagnosis either on clinical grounds or as the result of an explanation or a biopsy.

Bone Disturbances in Injuries to the Spinal Cord and Cauda Equina (Paraplegia): Their Prevention by Ambulation. Arthur S. Abramson.

J. Bone & Joint Surg. 30-A:982 (Oct.) 1948.

Certain bone disturbances occur with great frequency in injuries to the nerve contents of the vertebral canal. Some of these and their sequelae often are severe and crippling and may even be capable of shortening the life span.

Of this group of bone disturbances, atrophy and soft-tissue ossifications are the most important, because of the disabilities they may produce and because of the frequency of their recurrence.

Bone atrophy occurring in paraplegia is of an osteoporotic nature. There is close association of urinary calculi and soft tissue ossifications with the excessive calcium mobilization from the bones. If calcium could be held in bone, urinary calculi, soft-tissue ossifications and pathologic fractures could be prevented. Pressure produces bone matrix, thus allowing the deposition of calcium. The only logical therapeutic agent which applies pressure intermittently is ambulation.

Radiation Hygiene: Hazards to Physicians, Patients, Nurses and Others from Use of Radioactive Isotopes. W. Edward Chamberlain; R. R. Newell; Lauriston Taylor, and Harold Wyckoff.

J. A. M. A. 138:818 (Nov. 13) 1948.

The atomic age confronts the medical profession with seemingly unlimited opportunities, but equally with the gravest responsibilities. To match the eagerness with which he plunges into investigation of the tremendous possibilities of advance in medical knowledge, the physician investigator must possess the keenest awareness of the hazards to himself, his patients and working associates involved in the study and manipulation of radioactive isotopes and other products of atomic fission. Fundamental is the fact that there is no antidote to radiation injury. Prevention and unrelenting watchfulness are the requirements for what may be called radiation hygiene. Even physicians who are not engaged in this research must have knowledge of the technics involved, for they may have patients who have been exposed to radiations.

Many physicians are avid to put radioisotopes to work for medicine, to proceed as fast as possible to apply them to clinical problems and therapeutic arts. Are physicians going to be able to proceed at equal speed in learning the art of protecting their patients, themselves, their associates and communities from the grave and insidious dangers of these poisonous substances?

Longevity in Rheumatic Fever: Based on the Experience of 1,042 Children Observed Over a Period of Thirty Years. May G. Wilson, and Rose Lubschez.

J. A. M. A. 138:794 (Nov. 13) 1948.

The longevity in rheumatic fever for the first four decades of life is presented. An affected child has 4 chances out of 5 to survive fifteen years after the onset of the disease, 3 chances out of 4 to survive twenty years after onset and 2 chances out of 3 to survive thirty years after onset. The median duration of life for rheumatic children is greater than thirty years after onset. An affected child has 4 out of 5 chances to survive childhood (to the age of 10 years), 3 chances out of 4 to survive puberty and 19 chances out of 20 to survive early adult life. The over-all chance to survive to the age of 40 years is 1 out of 2.

Neurophysiological Disturbances Following Electric Shock Therapy (Electroencephalographic Observations). Andre A. Weil.

Ohio State M. J. 44:1017 (Oct.) 1948.

Electric shock therapy has gained greatly in popularity ever since Bini and Cerletti introduced this method in 1938. Its clinical usefulness has been proved by many investigators in combating schizophrenias, depressive emotional reactions, and even severe psychoneuroses. Neuropathologic studies have usually shown few, if any, structural changes in the central nervous system of animals after experimental electroshock treatment.

Electroencephalographic tracings after electroshock treatment reveal the appearance of epileptiform wave patterns. The practical application of this problem is discussed, summarizing the electroencephalographic observations in a large group of patients who submitted themselves to a course of electroshock therapy. It appears that unidirectional, fluctuating current produces less abnormal brain wave formations than the commonly used alternating current. More than ten shock treatments, although sometimes clinically necessary, produces generally longer lasting and more pronounced brain wave abnormalities. The youngest and oldest age groups show the most pronounced electroencephalographic abnormalities after shock treatment. It appears also, that a normal preshock electroencephalogram promises a better clinical result than an abnormal one.

It is therefore suggested that whenever clinically possible electroencephalographic studies should precede electroshock therapy. Psychotherapy should be substituted for electroshock treatment at least after ten treatments. Electroshock therapy should be used in older patients and very young individuals only after most careful selection of patients.

Effect of Electrical Stimulation Upon Atrophy of Partially Denervated Skeletal Muscle of the Rat. A. J. Kosman; E. C. Wood, and S. L. Osborne.

Am. J. Physiol. 154:451 (Sept.) 1948.

Although considerable experimental data have been accumulated concerning the effects of electrical stimulation upon the atrophy of totally denervated skeletal muscle, there is no direct information of the behavior of partially denervated muscles toward such treatment. And yet, in its clinical applications, electrotherapy of paralyzed muscles involves muscles whose denervation often is incomplete. The present studies were undertaken to obtain such experimental evidence.

Electrical stimulation by means of a modulated sinusoidal current with a carrier frequency of 25 cycles per second significantly retards the weight and strength loss of the gastrocnemius muscle of the rat which occurs following partial as well as complete motor denervation. The differences in weight and strength between treated and untreated muscles, which have been subjected to a partial denervation, become significantly greater as either the period of denervation or the extent of the denervation is increased. The difference in strength (and presumably weight) between treated and untreated muscles is due to the effect of the electrical stimulation on those fibers which have lost their innervation. The tension developed by those fibers whose innervation is still intact is apparently unaffected by daily electrical stimulation for periods of fourteen to twenty-eight days.

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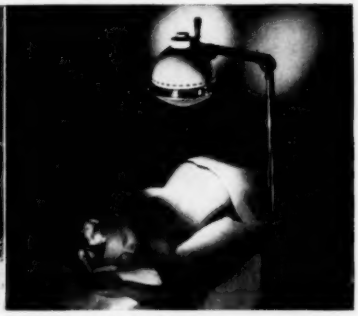

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WESTERN SECTION MEETING

The Western Section of the American Congress of Physical Medicine will meet in Los Angeles on May 5, 1949, immediately preceding the meeting of the California Medical Association at the Biltmore Hotel. An afternoon and evening program is being prepared. The details of the program are not complete, but those interested may write to the Secretary for further information. Open to members of the regular medical profession and properly sponsored registered physical therapists. Fred B. Moor, M.D., Secretary, Western Section.

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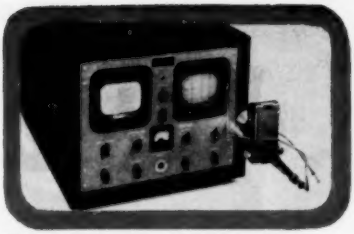

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EASTERN SECTIONAL MEETING

AMERICAN CONGRESS OF PHYSICAL MEDICINE

SATURDAY, APRIL 30, 1949

Academy of Medicine, Northern New Jersey

91 Lincoln Park **Newark, New Jersey**

PROGRAM

SATURDAY AFTERNOON, APRIL 30, 1949, 1:30 P. M.

Opening Remarks and Salutation, BROR S. TROEDSSON, M.D., Chairman of the Scientific Program of the New Jersey Society of Physical Medicine.

Amputations: Functional Problems at Various Sites as They Affect the Stump and Prostheses, HENRY W. KESSLER, M.D., Director of the Kessler Institute for Rehabilitation, West Orange, New Jersey.

Pathologic Gaits and Their Therapeutic Implications, JESSIE WRIGHT, M.D., Director, D. T. Watson School of Physiotherapy, Leetsdale, Penna.

Physical Medicine in a Changing Medical World, E. M. BLUESTONE, M.D., Director of Montefiore Hospital, New York, N. Y.

The Role of Physical Medicine in Diagnosis and Prognosis of Arterial Vascular Disease, MAX K. NEWMAN, M.D., Director of Physical Medicine Rehabilitation, Grace Hospital and Wayne University, Detroit, Mich.

Resistive Physical Technics in Neuromuscular Rehabilitation, RENE CAILLIET, M.D., Medical Supervisor, Kabat-Kaiser Institute, Washington, D. C.

EVENING SESSION — 6:00-9:00 P. M.

Military Park Hotel, 16 Park Place, Newark, New Jersey

DINNER — 6:00-7:15 P. M.

SYMPOSIUM ON REHABILITATION OF THE HEMIPLEGIC PATIENT

Moderator — WILLIAM BENHAM SNOW, M.D.

Discussion of the Problems Presenting in Patients with Hemiplegia, Prognosis Toward Recovery and Indications for Treatment, H. HOUSTON MERRITT, M.D., Director of Medical Service, Neurological Institute, New York, N. Y.

Speech Problems and Speech Training in Hemiplegic Patients, MARION CASS, Ph.D., Instructor in Speech Therapy, College of Physicians and Surgeons, Columbia University College of Medicine, New York, N. Y.

Physical Methods During the Subacute and Convalescent Stages of Hemiplegia, A. DAVID GUREWITSCH, M.D., Assistant Director, Physical Therapy, Columbia Presbyterian Medical Center, New York, N. Y.

The End-Rehabilitation of the Hemiplegic to Maximum Self-Sufficiency, SIDNEY LICHT, M.D., Regional Director, Veterans Administration, Boston, Mass.

ROUND TABLE DISCUSSION —

OPTIONAL OFFERING: Those attending the meeting are invited to visit the Kessler Institute for Rehabilitation, Pleasant Valley Way, West Orange, New Jersey. Inspection of the Institute, a discussion of how it functions and a talk by Miss Signe Brunstrom on "Rehabilitation of Severely Handicapped Individuals," will be included.

Those desirous of visiting the Institute will meet at the office of Dr. Henry Kessler, 53 Lincoln Park, Newark, New Jersey, at 10:00 A. M., Saturday, April 30, 1949. Transportation to the Institute will be provided and luncheon will be served to those attending as guests of Dr. Kessler. Ample time will be allowed to return for the Afternoon Session which starts at 1:30 P. M.

Kindly notify Dr. William B. Snow in advance of the meeting if you intend to visit the Institute of Rehabilitation, so that adequate transportation may be supplied.

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June 19-24, 1949

Tentative Program

Sunday, June 19 —

11:00 A. M. "Brunch" School Section
3:00 P. M. Registration
7:30 P. M. Formal opening of the 26th Annual Conference—Lois Ransom, President, American Physical Therapy Association
Greetings from Massachusetts Chapter
"New Horizons and New Responsibilities" — Howard A. Rusk, M.D., Director, The Institute of Rehabilitation and Physical Medicine, New York University — Bellevue Medical Center, New York, N. Y.

Monday, June 20 —

9:00-12 Noon General Session — House of Delegates
12:00- 2:00 P. M. Luncheon
2:00- 5:00 P. M. The Neurological Basis for Treatment of the Hemiplegia
Subject to be announced — Temple Fay, M.D., Director, Neuro-Physical Rehabilitation Clinic, Philadelphia
"The Rehabilitation of the Hemiplegia Patient" — Donald A. Covalt, M.D., Clinical Director, The Institute of Rehabilitation and Physical Medicine, New York University — Bellevue Medical Center, New York, N. Y.
7:30- 9:00 P. M. Movies

Tuesday, June 21 —

9:00-12 Noon The Neurological Basis for Treatment of Cerebral Palsy
Subject to be announced—Temple Fay, M.D., Director, Neuro-Physical Rehabilitation Clinic, Philadelphia
Subject and speaker to be announced
12:00- 2:00 P. M. Luncheon
2:00- 5:00 P. M. General Session — House of Delegates
7:30 P. M. Banquet (Informal)

Wednesday, June 22 —

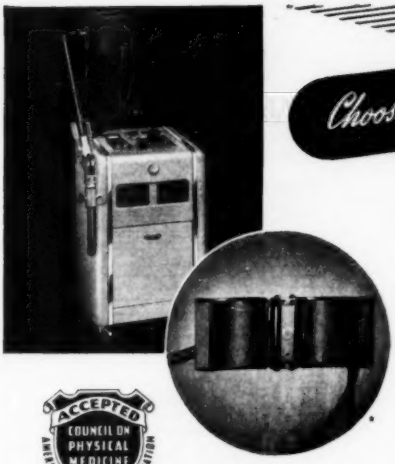
9:00-12:00 Noon Poliomyelitis
"Poliomyelitis" — Thomas Gucker III, M.D., Massachusetts Infantile Paralysis Clinics of the Children's Hospital, Boston, Mass.
"Early Care of the Poliomyelitis Patient" — Demonstration — Shirley Cogland, Assistant Technical Director, Department of Physical Therapy, Children's Hospital, Boston, Mass.
Theresa Fallon, Consultant
Joint Orthopedic Nursing Advisory Service, New York, N. Y.
12:00- 2:00 P. M. Luncheon
2:00- 4:00 P. M. The Neurological Basis for Treatment of Multiple Sclerosis
"Multiple Sclerosis" — Leo Alexander, M.D., Director, Multiple Sclerosis Clinic, Boston, Mass.
7:00- 9:00 P. M. General Session — House of Delegates

Thursday, June 23 —

9:00-12:00 Noon "Some Research Problems in Physical Therapy" — Arthur L. Watkins, M.D., Associate in Medicine, Harvard Medical School, Chief of Physical Medicine, Massachusetts General Hospital, Boston, Mass.
Papers on Research — Graduate Students in Physical Therapy Schools — selection of papers to be announced.
12:00- 2:00 P. M. Luncheon
2:00- 5:00 P. M. Arthritis
Subject to be announced — Walter Bauer, M.D., Massachusetts General Hospital, Boston, Mass.
"Some Psychiatric Problems Related to Arthritis" — Alfred O. Ludwig
"Physical Therapy in the Treatment of Arthritis" — Mary L. Nesbitt, Supervisor, Physical Therapy Department, Massachusetts General Hospital, Boston, Mass.
7:30 P. M. Concert — Boston "Pops"

Friday, June 24 —

9:00-12:00 Noon Clinical Demonstrations
Main Amphitheater, Peter Bent Brigham Hospital
"Fractures" — T. B. Quigley, M.D., Assistant Chief of Surgery, Peter Bent Brigham Hospital, Boston, Mass.
Auditorium — Massachusetts General Hospital
"The Beasley Electronic Myodynometer" — Arthur L. Watkins, M.D., Associate in Medicine, Harvard Medical School, Chief of Physical Medicine, Massachusetts General Hospital, Boston, Mass.
"De Lorme Exercise Table" — Thomas De Lorme, M.D., Research Fellow, Department of Physical Medicine, Massachusetts General Hospital, Boston, Mass.
12:00- 2:00 P. M. Luncheon
2:00- 4:00 P. M. "Open House" — in various physical therapy clinics in the Boston area



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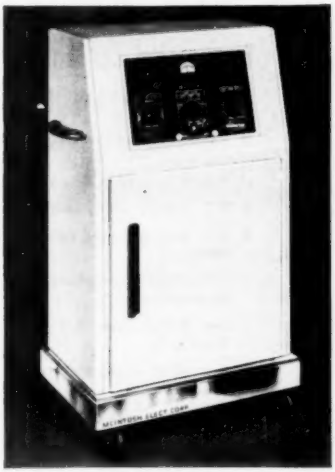

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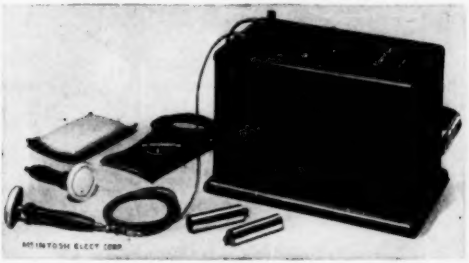

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